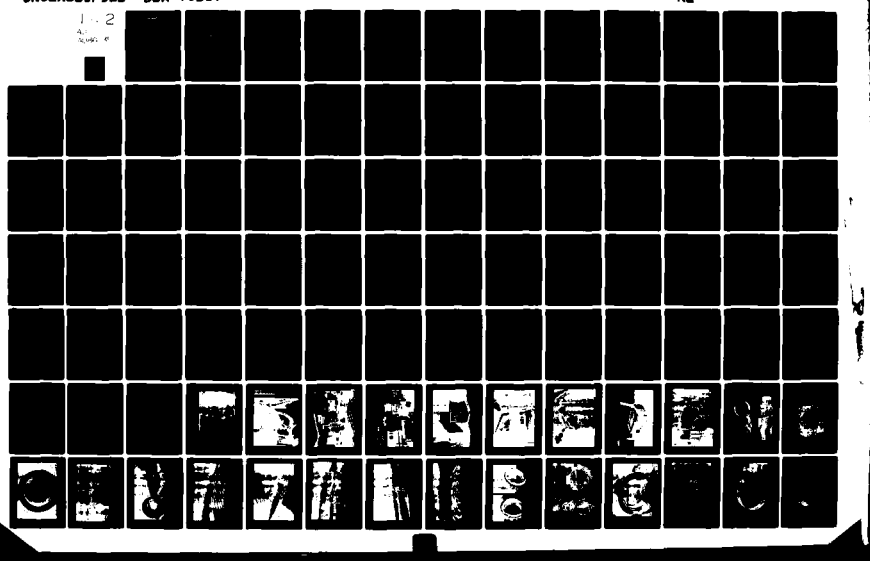
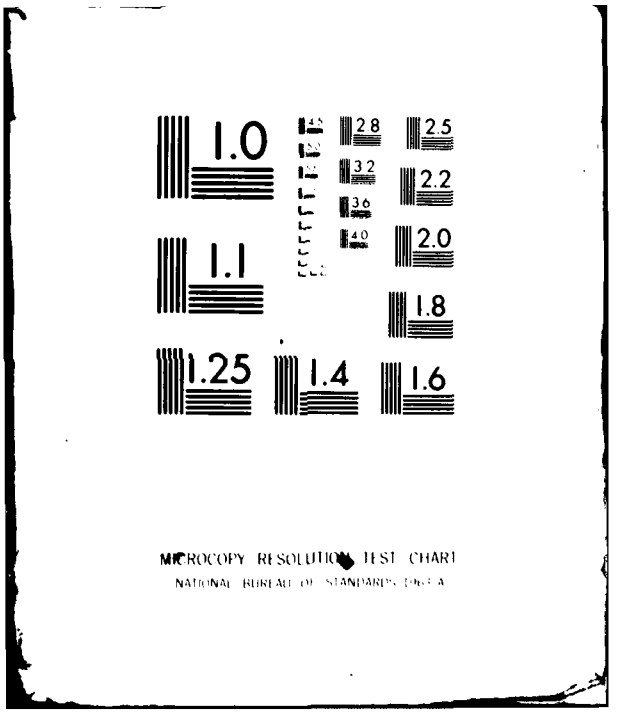
AD-A086 035 GENERAL MOTORS CORP INDIANAPOLIS IN DETROIT DIESEL A--ETC F/G 10/2
ENVIRONMENTAL AND COLD TESTS ON MODEL 04045803 GENERATOR SET SE--ETC(U)
NOV 79 H E GASTON DAAK70-78-C-0124
UNCLASSIFIED DDA-79087 NL

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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

LEVEL II



**Detroit Diesel Allison**
Division of General Motors Corporation
Indianapolis, Indiana

REPORT NO. (14) DDA-79D87

DATE 11-9-79

(12)

(9) ENGINEERING TEST REPORT

(6) ENVIRONMENTAL AND COLD TESTS ON MODEL 04045B03 GENERATOR SET SERIAL NUMBER 0000003 WITH IGT 404-4 ENGINE SERIAL NUMBER T000003.

TEST UNIT _____

(11) 9 Nov 79 (12) 101



MODEL Engine - IGT404-4 Generator Set 04045B03

DATE November 13, 1979

PROJECT P580-01 *P568-06

PREPARED BY Harris E. Gaston

(10) HARRIS

(15) CONTRACT DAAK70-78-C-0124 DAAK70-78-0056

APPROVED D. M. Hall
D. M. Hall, Supv.

FILE CLASS AD0097 *AD5210 (C-)

GROUP IGT Test Projects

TEST REQUEST AD0097-02-(EDO-Open) *AD5210-01-501A

DEPARTMENT Industrial Engine Test

CLOSED *X OPEN _____

TEST STARTED 6-28-79

TEST COMPLETED 9-24-79

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DESCRIPTORS:

IGT Generator Set
208 Volts, 400 Hertz, 150 Kilowatts
+125°F, 5,000 Ft. Alt. & 107°F,
8,000 Ft. Alt. & 95°F, -25°F, -50°F
Power Turb Brg Failure

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FORM 2250-1 (REV. 2-73)

019200

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## ABBREVIATIONS AND SPECIAL WORDS

| | |
|---|---|
| A, amps | Amperes |
| accel | Acceleration |
| Avg | Average |
| CB | Circuit breaker or interrupter |
| cc | Cubic centimeters - measure of start fuel flow |
| DC | Direct current |
| $^{o}$ or $^{o}F$ | Degrees fahrenheit |
| $\Delta T$ | Differential temperature |
| DFA | Arctic diesel fuel for cold testing |
| DF2 | ASTMD-975 #2 diesel fuel |
| ECA | Electronic Control Assembly |
| ETR | Engineering Test Report |
| ft | Feet (altitude in most applications herein) |
| F.U. | Fire-up or start |
| Fuzz | Minor metallic particles as contrasted to "chips" |
| Gen Set | Generator set model number 04045B03, Serial 0000003 |
| Hz | Hertz--measure of output frequency and a direct indication of generator set speed |
| IF | D.C. current to operate the fuel valve |
| K(5) | K number represents a control relay |
| KW | Kilowatts - electrical load applied |
| lab | Fuels laboratory at Plant 5 |
| ma | Milliamperes - measure of fuel valve current |
| Mil-Std 705B | The Military Specification applied to the test |
| min | Minimum or minutes |
| MOP | Main oil pressure |
| $N_1$ | Gasifier speed recorded from the ECA test connector |
| $N_2$ | Output speed recorded from the ECA test connector |
| NEG | Negligible - used in connection with measurements where the width of the printed line is as wide as the variation of the line level. |
| No., # | Number |
| O.T. | Overtemperature |
| O.V. | Overvoltage |
| PD | Purchase Description document |
| % | Percent |
| <,> | Less than, greater than |
| pf | Power factor, lagging |
| P/N | Part number |
| pt | Point (Cloud pt, pour pt, etc.,) |
| psig | Pounds per square inch - gage, pressure |
| QC | Quality Conformance, Quality Control as applicable to instrumentation |
| qts | Quarts |
| RDG | Reading - hand data |
| rpm | Revolutions per minute - speed |
| SEC | Second (time) |
| S/N | Serial number |
| STD | Standard |
| Standard Instrument | The special calibrated generator monitor for reading accurate electrical data. |
| $T_1$ | Temperature at engine air inlet |

Abbreviations & Special Words (Continued)

| | |
|---|---|
| $T_4$ | Burner outlet or gasifier turbine inlet temperature read from a pair of commercial control thermocouples |
| $T_6$ | Power turbine outlet temperature |
| TI | Texas Instruments, 2 channel recorder |
| UV | Undervoltage |
| V | Volts |

## FOREWORD

The purpose of this test was to conduct environmental tests at +125°F, 5,000 Ft. altitude and 107°F, 8,000 Ft. altitude and 95°F and with 60° ΔT (from about 80°F to 20°F). These tests were to be completed per Test Request AD5210-01-501A, Purchase Description and Military Specification Mil Std 705B. In addition, the testing was to include cold testing at -25°F and -50°F to meet the requirements of the Purchase Description and Mil-Std 705B. The Environmental tests were to be completed on Contract No. DAAK70-78-0056 while the cold tests were to be covered on Contract No. DAAK70-78-C-0124.

## SUMMARY

Model 04045B03 Generator Set S/N 0000003 (with IGT 404-4 Engine S/N T000003) was installed in Test Cell 873 for environmental tests and Cold tests on June 28, 1979. Initial ambient checkout tests were completed June 9 after correcting various test equipment problems. Engine-gen set problems involved failure of two reverse polarity diodes and several "undervoltage load dump" incidents.

The test results at +125°F, ambient pressure conditions were as follows: (Addendum B)

1. The unit was running with a blinking overtemperature (OT) light at rated power, and underspeed tests could not be accomplished without T6 overtemperature shutdowns.

2. During the Regulator Range test, and all subsequent testing, the Texas Instruments (T.I.) recorder indicated high voltage regulation values while the "standard instrument" indicated values well within limits. This was probably due to hysteresis in the T.I. recorder.

3. Undervoltage load dumps were due to a broken wire causing a ground on relay K7. This was corrected.

4. Only one of one hundred five parameters was out of limits on the indicating instrument test (panel comparison).

5. Transient conditions were out of limits on 12 of 70 parameter conditions on the Frequency and Voltage Regulation, Stability and Transient Response test. Four (4) of these twelve (12) parameters were voltage regulation as measured by the T.I. recorder which is suspected of hysteresis.

6. The overload relay could not be set properly.

7. Long term stability was within prescribed limits.

8. After installation of parallel reverse polarity diodes, the DC control tests were successful.

9. Battery charging tests successfully demonstrated the necessary capability.

10. The Run, Shutdown, and Restart test was successful.

11. Overvoltage relay operation was up to 5.8 percent faster than the .180 second minimum limit.

12. Voltage Dip and Rise tests were satisfactory.

During the $60^{\circ}\Delta T$ test (Drift) the regulated voltage and frequency remained within prescribed limits.

Engine and exciter parameters performed as expected with characteristic reductions as the ambient temperature was reduced (Enclosures AD5210-00012 and 00013).

All testing at 5,000 feet altitude and $107^{\circ}F$ was accomplished with the O.T. light blinking at 148.2 KW (1.21 percent below the 150 KW rating). At one point the power was raised to 150 KW and the OT light was still not on all the time. The tests at 5,000 feet altitude and $107^{\circ}F$ had the following results: (Addendum C)

1. On the Regulator Range test, all parameters were within limits (based on the standard instrument digital data).

2. The results of the Frequency and Voltage Regulation, Stability and Transient Response test indicated nine (9) frequency transient parameters plus five voltage regulation (from TI recorder) were out of limits.

3. On the indicating instrument test at 5,000 feet and $107^{\circ}F$, eight (8) voltage readings (at 75 and 100 percent load) were erroneous beyond allowable limits.

4. Testing could not be done at rated load, underspeed conditions.

The testing at 8,000 feet altitude (Addendum D) with rated power at 138 KW provided the following results:

1. The errors in voltage readings, on the indicating instrument test, were on seven (7) of the same eight (8) that were erroneous at 5,000 feet and 107°F.

2. The Regulator Range test results were good, based on the standard instrument data.

3. Testing could not be accomplished at underspeed, rated load conditions.

4. During the Frequency and Voltage Regulation, Stability and Transient Response test, seven (7) frequency transient parameters and three (3) voltage regulation values (based on T.I. recorder) were out of limits.

An overtemperature shutdown was demonstrated with 125°F conditions in the test chamber. The engine reached the acceleration temperature limit and the O.T. shutdown limit at about the same time. But, due to the OT shutdown delay, the engine decelerated to an underfrequency trip condition, then shut down at the same time it was unloaded.

During the preparations for -25°F Cold testing a starter solenoid failure caused extended motoring. This motoring, in turn, appeared to have caused, due to inadequate lubrication, a gasifier pinion gear bearing failure.

After the unit was repaired, three tests were attempted unsuccessfully after 24 hour soak (each) at -25°F. Testing on a field engine indicated that reduction in the clutch cooling oil flow allowed successful starts at extreme cold conditions. With the installation of a plug to reduce clutch cooling oil flow, the -25°F start and operation were successful. The following results were obtained at -25°F: (Addendum E)

1. The Regulator Range test results based on the standard instrument were within limits.

2. The only values out of limits on the Frequency and Voltage Regulation, Stability and Transient Response Test were voltage regulation values (4 places) based on TI recorder data.

3. The instruments on the gen set were out of limits on 20 of 45 voltage values (error as high as 3.8 volts at 208 volts) on the Indicating Instrument test.

After the normal preparations, the -50°F testing was initiated with a successful start and loading within one minute. However, soon after the loading occurred, the unit emitted two howls and a loud "pop." The pop was apparently due to the quill shaft failing as secondary damage when the power turbine roller bearing failed (lack of lubrication - cooling).

The engine was repaired, check run and shipped to MERADCOM, Ft. Belvoir, VA. Further design analysis is being accomplished to prepare future engines for extreme cold operation. No corrections were made for this problem in engine S/N 0000003.

## RECOMMENDATIONS

1. Since the P.D. dated August 3, 1979, still contains the requirement to load to rated load in one minute, further cold tests should be conducted (prior to production units) to insure that the changes for extreme cold operation are satisfactory. A Purchase Description change should be considered.

2. The average engine must be improved to insure satisfactory performance at altitude or hot day and underspeed (388 Hz) conditions.

3. Improvements in the overload relay and main circuit interrupter should be proven before production (first Article) test are initiated.

4. The frequency adjustment range should be extended so the adjustment is not marginal for the tests requiring ±3 percent adjustment.

5. Serious consideration should be given to the possible problem of icing or blockage of the air inlet particle separators (filters). One possibility might be to increase the compressor discharge bleed flow, at an unloaded condition, to warm up and defrost the filters.

6. Since the PD (August 3, 1979) has not changed relative to the frequency transients, significant changes are required to meet the limits. Additional testing should be accomplished to prove those fixes. This also may require a P.D. change.

## DISCUSSION

### Factual Data

| | |
|---|---|
| Generator Set Model No. | 04045B03 |
| Generator Set Serial No. | 0000003 |
| Generator Set Builds | 4-6 |
| Engine Model No. | GT404-4 |
| Engine Serial No. | T000003 |
| Engine Builds | 6-8 |
| Test Stand No. | 873 |
| Fuel | DF2/DFA |
| Lube Oil | MIL-L-7808 |
| Test Started - Date | 6-28-79 |
| - Clock Time | 29.6 Hrs. |
| - Gen Set Time | 29.6 Hrs. |
| - Engine Time | 76.0 Hrs. |
| Test Ended - Date | 9/24/79 |
| - Clock | 150.9 Hrs. |
| - Gen Set Time | 142.9 Hrs. |
| - Engine Time | 196.1 Hrs. |

### Test History

Generator Set Model NO. 04045B03, Serial No. 0000003 was installed (beginning June 28, 1979) in Test Cell 873 following Quality Conformance Tests (ETR 79D63) and subsequent "purchase" by the Army. The instrumentation list (Addendum F) includes a list of parameters, types of instrumentation, readout equipment, etc. All instrumentation was maintained in proper Quality Control throughout the test.

Photographs 350363 through 350369 show, respectively, the control room, TV monitor, load banks (see 7/5/79 below) generator set installation, battery cart and fuel system. The installation was completed July 3, and the initial check out, at ambient conditions, was started. The following chronology provides the pertinent events during this initial checkout:

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 7/3/79 | 29.6 | Initial fire-up. |
| | 30.1 | Had a "low fuel" shutdown. Found the test equipment fuel valve wired wrong and the CB-2 circuit breaker open. Corrected the wiring. |
| 7/5/79 | 30.2 | Replaced a shorted K-5 relay which was allowing the set fuel pump to run continuously. |
| | 30.6 | Had low T4 on fire-up--found the T1 temperature sensor failed. Replaced the sensor with new part (Same P/N). |
| 7/5/79 | 33.5 | Had T1 and T4 fluctuations and fluctuations on generator set voltage. Found the DC control relays in the load bank "chattering." Repaired the chattering by supplying separate 28V supply to the relays. Also added a grounded shield to the external voltage adjusting potentiometer. |
| | 34.3-34.5 | On five (5) occasions, the undervoltage (U.V.) relay operated to open the main contactor (CB5) and drop the load. In addition, the load bank was not supplying sufficient load (150 KW) because of the voltage drop due to the long load lines. |
| | 34.5 | Connected a second load bank to provide a complete 150 KW 0.8 power factor (pf) load. |
| 7/6/79 | 34.5-34.6 | Had 2 more U.V. relay "dumps" while instrumentation was indicating 208 volts on all phases. |
| | 34.7 | Found and corrected a "short" at the K-7 relay. Did not correct the U.V. light problem. |
| | 35.2 | Overload relay dropped the load--increased the setting by 1/4 turn clockwise. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | 35.5 | Experienced fluctuations in T4--appear to have exhaust recirculation. Wrapped exhaust stacks. Had to add a fan to assist the exhaust up the stack. |
| | 36.3 | Test equipment emergency stop switch did not shut the unit down when checked. Found the cable connector only partially plugged in. |
| | 37.4-40.2 | Completed indicating instrument test (PD27 - MIL-STD-705, Method 513.1) at ambient conditions (See Test Results). |
| 7/7/79 | 40.2 | Battery charging alternator would not charge (hooked up to a load bank only) until excited from battery (+) terminal. |
| | 42.5 | Completed battery charging test. Started D.C. Control test per MIL-STD 705B method 655). Batteries upstairs would not crank the unit, apparently due to low charge and extremely long (and small) battery leads. Used the auxilliary set in the special battery cart (See Photo 350368). |
| | 42.6 | During the reverse polarity check (in the D.C. Control test) the reverse connection resulted in failure of the special diode. (See Photo 348568 for a typical reverse polarity system). A battery post was damaged also, during an attempted battery hookup before the diode was replaced. |
| 7/9/79 | 43.0 | Installed a new diode (Rev. polarity) and replaced the damaged battery. Attempted a reverse polarity connection and again failed the system diode. Replaced the diode again. |
| | 43.3 | Successfully completed DC Control test (MIL STD 705B, method 655.1), except the reverse polarity test. |
| | 44.9 | Completed rerunning the Battery Charging test per PD paragraph 4.4.1 (See test results). |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 7/10/79 | 44.9 | Start of 125°F Testing<br><br>NOTE: The test chamber open tip and oil bath thermocouples plus the engine oil temperature were raised to $125^{+5}_{-0}$°F before starting each day's testing. All testing then was conducted at 125-130°F chamber temperature. |
| | 47.5 | The frequency adjust test at 125°F (MIL-STD 705B, Method 511.2) was completed through the stabilization and max speed adjustment. However, when an attempt was made to reduce frequency to the 388 Hz setting, the unit shut down due to T6 (turbine outlet) overtemperature when frequency was reduced to 395 Hz. (See "Test Results"). Had a high T4 spike on the next fire-up. |
| 7/11/79 | 51.4 | The Regulator Range test (Method 511.1) was started but U.V. relay load "dumps" occurred 5 times and the test was aborted. |
| | 51.6 | One (1) additional U.V. relay load dump occurrence preceded the discovery of a broken wire which was intermittently grounding the relay (K7). This broken wire was repaired. |
| | 54.4 | The Regulator Range Test (PD#29, MIL-STD 705B, Method 511.1) was completed. (See "Test Results") |
| | 57.3 | The Indicating Instrument test (PD#27, MIL-STD 705B, Method 513.2) was completed except the 150 KW, 0.8 pf load point at 388 Hz (underspeed). This point could not be run because of high turbine outlet temperatures.(See "Test Results") |
| 7/12/79 | 60.5 | Completed the Frequency and Voltage Regulation, Stability (short term) and transit Response Test at 125°F (PD#17, MIL-STD 705B, Method 511.2). See "Test Results". |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 7/12/79 | 64.0 | Completed overload relay test at 125°F (PD paragraph 3.10.3.3 and relay print). See "Test Results." |
| 7/13/79 | 75.2 | Completed Long Term Frequency and Voltage Stability Test at 125°F per PD#20 and MIL STD 705B, method 608.2; See "Test Results." |
| 7/16/79 | 75.2 | Installed a second diode in parallel with the first reverse polarity diode. |
| | 75.8 | Had a shutdown, during the D.C. Control test, when batteries were disconnected. Found a loose connection at the new diode installation. Shorted the alternator diode trio during alternator adjustment. Replaced the diode trio assembly. |
| | 77.1 | Completed DC Control test at 125°, per PD#37 and MIL STD 705B, method 655.1, including the reverse polarity battery hookup. See "Test Results." |
| | 78.4 | Completed Run, Shutdown, and Restart test at 125°F (per MIL STD 705B, Method 710.1). See "Test Results." |
| | 78.6 | While setting up for overvoltage (OV) and undervoltage (UV) tests, the external resets appeared not to work properly. |
| 7/17/79 | 80.3 | Completed the "Circuit Interrupter - Overvoltage and Undervoltage Test" at 125°F per PD#26, MIL STD 705B, Method 512.3. See "Test Results." |
| | 81.1 | During the process of adjusting the alternator regulator, while running the Battery Charging Test at 125°F, the adjustment was overtorqued, failing the regulator. The alternator was replaced. |
| | 83.4 | Completed Battery Charging Test at 125°F per PD paragraph 4.4.1. See "Test Results." |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | 86.5 | Completed voltage dip and rise test at 125°F per PD #24, MIL STD 705B, method 619.2. See "Test Results." |
| 7/18/79 | 86.5 | Start of 60° ΔT Test |
| | 96.3 | Completed 60° ΔT test from 81° (stabilized) to 21°F with stabilization per PD 19, paragraph 4.4.5.<br><br>See "Test Results." Found left rear T4 thermocouple was not connected onto the junction block. (Added one (1) quart of MIL-L-7808 oil) |
| 7/19/79 | 96.3 | Start of Test at 5000 Feet Altitude & 107°F<br><br>At 107°F and 5,000 ft. altitude, over-temperature light is blinking at 148.2 KW. |
| | 100.4 | Completed Regulator Range test at 5,000 ft. and 107°F per PD#29 MIL STD 705B, method 511.1. Power was limited to about 148 KW because of overtemperature light blinking. See "Test Results." |
| | 103.5 | Completed Frequency and Voltage Regulation, Stability (short term) and Transient Response test at 5,000 ft. altitude and 107°F per PD#17, MIL STD 705B, method 608.1. See "Test Results." |
| 7/20/79 | 104.8 | While conducting the Indicating Instrument test, lost the magnetic drain plug "continuity" (yellow) light. |
| | 106.0 | Completed Indicating Instrument test at 5,000 Ft. altitude and 107°F per PD#27 MIL-STD-705B, method 513.1. See "Test Results." Note: Could not run 388 Hz with 148.2 KW load. |
| | 106.7 | Extended power to 150 KW and obtained data at 400 Hz. O.T. light still blinking with observed T4 at 1944°F. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | 106.7 | Start of Test at 8,000 Feet Altitude and 95°F (138 KW) |
| | 108.7 | Completed Indicating Instrument test at 8,000 ft. altitude and 95°F per PD#27, MIL STD 705B, Method 513.1 with 138 KW rated load. Unable to complete 388 Hz, rated load point. See "Test Results." |
| 7/21/79 | 108.9 | On the first load application of the day, to 138 KW (8,000 ft. and 95°F), the O.T. light stayed on steady with 1950°F on the chart (T4 signal from box). The load was cycled a few times and the T4 temperature reduced to 1935 with the O.T. light blinking. |
| | 113.1 | Completed Regulator Range test, at 8,000 ft. altitude and 95°F, per PD #29, MIL-STD-705B, method 511.1. The overtemperature light blinked off and on during the test at 138 KW (rated power). See "Test Results." |
| | 116.6 | Completed Frequency and Voltage Regulation, Stability and Transient Response test, at 8,000 feet altitude and 95°F, per PD#17, MIL-STD 705B method 608.1. See "Test Results." |
| | 117.2 | Returned to Ambient Pressure, 125°F Conditions. Completed overtemperature safety device test at 125° per PD#40, MIL-STD-705B, method 515.2a. After the OT shutdown, the underfrequency lamp stayed lighted, even when the main switch was turned off. Checked over external wiring and underfrequency lamp went out--did not take positive corrective action. |
| | 117.2 | Start of -25°F Preparation and Testing. Cleaned the magnetic drain plug of small amount of "fuzz." |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 7/23/79 | 118.0 | Attempted start with batteries from upstairs-no fire-up attained and voltage dropped to 17.3 volts. About 5-10 minutes later the unit was found motoring. Removed the battery connector to stop the unit. Closed the manual fuel shutoff valve, hooked up the set internal batteries and motored to clear the unit of fuel (if any). Again the unit did not quit cranking and battery cables had to be removed. Found the starter solenoid contacts stuck closed. Replaced the starter assembly. |
| | 119.1 | Experienced a magnetic drain plug indication (light and alarm) while conducting a battery charging run. |
| | 119.4 | Checked magnetic drain plug. Found significant accumulation of larger chips on magnetic drain plug and removed the unit for disassembly. |
| 7/24/79 | 119.4 | Teardown 4, BU5 on Gen Set<br>Teardown 6, BU7 on Engine<br>Disassembly of the generator set and the engine gearbox revealed that the rear bearing on the gasifier pinion gear had failed.(See Photo 350444), allowing the pinion to move rearward and contact the rear pinion bearing support. The long motoring period at 118.0 hours, probably with inadequate oil flow to this bearing, appeared to be the cause of the failure. |
| 7/25/79 | 119.4 | Completed the rebuild of the engine and generator set and started installation in Test Cell 873. Replaced the auxilliary battery power receptacle because it was burned during the problems of 7/23/79 at 118.0 hours. |
| 7/26/79 | 119.5 | Shut down two times to clean "fuzz" from the magnetic drain plug. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | 120.4 | Recordings indicated significant T4 and If spikes during 50 percent load transients. With the droop switch on, no spikes occurred. Ran a bench test on the ECA and could find no difficulty. Subsequently, adjustments on load pulse during the ensuing run appeared to correct the problem. |
| | 121.3 | Completed the engine-generator set checkout. |
| | 121.9 | Completed preparations for -25°F start and run. All DFA fuel in the system was processed through Army H2O separator. |
| 7/27/79 | 121.9 | -25° Cold Test. Started the 24 hour cold soak at 00:00 o'clock 7/28/79. |

After 16.8 hours soak at -25 to -30°F a formation of white material appeared in the fuel sample which was visible in the test chamber window. The fuel in various supply drums and in the test chamber drums was sampled with the following results:

| Drum No. | API | Pour Pt | Cloud Pt |
|---|---|---|---|
| 1B | 39.7 | <-70 | -70 |
| 2B | 39.7 | <-70 | -72 |
| 3B | 39.9 | <-70 | -68 |
| 4B | 39.9 | -80 | -68 |
| 5B | 39.8 | -80 | -68 |
| 6B | 39.8 | <-65 | -68 |
| 7B | 39.7 | -70 | -68 |
| 8B | 39.8 | -70 | -68 |
| 9B | 39.9 | -70 | --- |
| 10B | 39.7 | -75 | --- |
| *12B | 37.5 | -50/-30 | -4 |
| *Test System | 38.0 | -45 | -8 |

*The lab reported that the sample from 12B and from the test cell systems were contaminated with some foreign material. When cooled, the samples would form a "frozen" network throughout. But if these samples were stirred, the network broke up and disolved immediately.

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | | The -25° cold test was aborted, the fuel system cleaned out and rinsed and refilled with fuel from good drums. The gen set day tank was drained and refilled with good fuel; fuel was pumped through the engine system as in fuel priming and both fuel filters were replaced with new clean filters. |
| 7/28/79 | 122.2 | Completed a battery charging, engine drying run during cool down. |
| | | Started -25°F Cold Soak at 0600 |
| | | Following the two (2) mandatory 15 second motorings, three cold start (-25°F) attempts were unsuccessful because light-off which occurred during quick fill were not recognized. The quick fill (fuel valve) current was increased from 85 milliamps (nominal) to 195 ma. Four (4) additional start attempts were shutdown with "no light-off" or "failed sensor" shutdowns. |
| | | The cold auxilliary batteries were connected and two additional start attempts were also unsuccessful (The two mandatory, 15 second, motorings were made before these start attempts). |
| | | The unit was motored to blow out any excess fuel and the start flow (fuel) adjustment was turned to "max." The auxilliary batteries were disconnected and more start attempts were made with the set batteries. During these the diverter valve was pecked on, the fuel system return hose was capped off, and start flow checks were made (100 cc). |
| | | The auxilliary batteries were reconnected for one start attempt (also unsuccessful) and the warm auxilliary batteries were then moved into the chamber and connected to the unit. On the fourth attempt, 1320°F T4 was reached but the unit shut down with an overcrank. The fifth attempt with warm batteries (the 28th attempt in 3 hours, 42 minutes) was successful. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| | 123.0 | After a battery charging run, the 24 hour soak was restarted for another cold start attempt. The chamber temperatures were held at -25°F. |
| 7/20/79 | 123.0 | Following the two (2) fifteen second motorings, eleven (11) start attempts were unsuccessful. Had fuel on cc checks and could hear ignition. Facilities went down due to surged unit.<br><br>Found the fuel nozzle had a plugged pilot orifice--blew it out with dry nitrogen. Two additional attempts with warm batteries reached higher temperatures but the 2nd of these was manually aborted because facilities were not flowing air and recirculation was occurring. The -25°F test was again aborted. |
| 7/31/79 | 123.0 | The fuel system components were bench tested with the following results:<br>Control Box - o Cold test--no affect.<br>o Changed sensing to recognize light-off during quick fill.<br>o Lowered failed sensor shutdown from 200° to 100°F.<br>o Changed quick fill dropout from 8 percent to 12 percent speed.<br>o Reset quick fill to 120 ma.<br>o Reset start flow to standard.<br>o Added 100 ohm buffer in If circuit of test connector.<br>Fuel Nozzle - Flow satisfactory<br>Fuel Valve - Increased pressure relief valve setting.<br>Spin samples and cold samples of fuel did not show any indication of water. Fuel samples from the primary fuel filter, the day tank, and the secondary fuel filter were analyzed for water content and, respectively, showed .006, .005, and .006 percent $H_2O$ by volume. The fuel specific gravity was .8276 at 60/60°F. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 8/1/79 | 123.0 | Started the following action to achieve starts on next cold test:<br>1. Circulating fuel through a chilling/filtering system to try to remove $H_2O$ from system.<br>2. Recharging batteries. |
| 8/2/79 | 123.0 | Found Army supplied water separator had come apart inside. Sent to the Instrument Lab for repair (This unit may not have been working at any time!). Continued circulating fuel. Reinstalled the fuel system parts.<br><br>Added "Prist" fuel drying compound to remove any moisture from the engine system. |
| 8/3/79 | 123.2 | Completed a run to "low fuel level" shutdown to run "Prist" dried fuel through the engine. Drained the remainder of this fuel from the day tank and replaced both fuel filters. All fuel in fuel system chilled/filtered and covered with a dry nitrogen purge. A fuel sample from system checked 39.8 API and .004 percent $H_2O$ by volume. |
| 8/3/79 | 124.1 | Completed a battery charging run which should also have purged the remaining "Prist" from the engine system. Starting to cool down for -25°F cold test. Started 24 hour soak at 17:20 o'clock. |
| 8/4/79 | 124.1 | Checked system - Gen set doors operated satisfactorily. Fuel and oil samples were clear. Completed 2 mandatory 15 second motorings.<br><br>Attempted seven (7) unsuccessful starts. All were shut down on overcrank with a maximum temperature of 1550°F. The quick fill resistor was clipped to raise the quick fill flow level but the board collected frost (apparently) and three (3) subsequent attempts displayed odd quick fill current levels.<br><br>Aborted -25°F Test. |
| 8/6/79 | 124.1 | Removed ECA and T6 control box for bench test. Also removed fuel pump and fuel valve for bench tests. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 8/7/79 | 124.1 | Removed fuel nozzle, 3-way valve, 2-way valve and diverter valve (plus lines and bracket) for a "system" cold bench test. (See ETR 79D30 for the results of the system cold test. |
| 8/13/79 | 124.1 | Discovered a wire in the Control Console which had the insulation worn off. |
| 8/27/79 | 124.1 | NOTE: Cold tests have been conducted, by the Army, at Ft. Belvoir, VA; and design engineering has determined the probable cause of the start failures to be the excess cold oil in the clutch because of the mandatory cranks. |
| | | Removed the two paralleled reverse polarity diodes and installed a single large diode. |
| 8/29/79 | 124.1 | Circulating fuel through the repaired Army separator and it is now removing some water and other foreign material. |
| | | Conducted a shaker test on the control console and found the entire wiring panel exhibited significant resonant vibration at 50 Hz (generator rotational frequency). Repaired three shorted or broken wires and provided improved protection for others in the control console. |
| 8/30/79 | 124.1 | Reinstalled 3-way and 2-way fuel valves. Chilling and filtering fuel in fuel system. |
| 9/4/79 | 124.1 | Installed a plug in the clutch cooling oil passage to reduce clutch cooling oil flow. Reinstalled a new fuel nozzle, a replacement fuel pump and fuel valve and a new diverter valve. |
| 9/5/79 | 125.3 | Completed check runs to correct fuel leaks and to check operation with replacement parts. |
| | 125.5 | Completed battery charging and engine drying run during start of cooling cycle. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 9/6/79 | 125.5 | Started on 24 hour soak at 00:00 o'clock. Added 2 quarts of oil to raise level in engine 2 qts. above full per new level requirements. |
| 9/7/79 | 127.0 | -25°F Cold Test<br><br>The unit fired successfully (after the two motorings) and the first portion of the cold test (through the no-load engine oil stabilization run) was completed. While running with rated load, following the engine oil stabilization, the unit decelerated and "dumped" the load on an "underfrequency trip," then recovered to max speed. An inspection of the engine revealed that the inlet air filters were clogged with frost.<br><br>Attempted to brush off the screens and blow out the frost with dry nitrogen. |
| | 129.5 | Maintaining -25°F chamber temperatures. Made three additional runs, attempting (unsuccessfully) to keep the inlet filter clear. Finally removed the inlet filters and installed filter shells only.<br><br>NOTE: Facilities had a heat exchange leak allowing moisture into the cold system. This was the cause the icing and frost formation. |
| | 134.5 | Completed Regulator Range test at -25°F per PD#29, MIL STD 705B, method 511.1. During the testing at 150 KW and 197 volts, the overload relay dumped the load. The test was completed without further problems (See "Test Results"). |
| | 137.9 | Completed frequency and voltage regulation, stability (short term) and transient response test at -25°F, per PD#17, MIL STD 705B, method 608.1 (See "Test Results").<br><br>NOTE: It was necessary to brush frost from the engine and generator air inlet screens on occasion during the tests. |
| | 138.0 | Unit shut down with "low fuel." Added DFA (dried) fuel to system. |

| Date | Gen Set Hrs. | Event |
|---|---|---|
| 9/8/79 | 139.0 | While conducting the indicating instrument test, the unit shut down for no know cause. |
| | 140.5 | Completed the indicating instrumenttest at -25°F per PD#27, MIL STD 705B, method 513.1. See "Test Results." Started warming the test chamber and started setting up for -50°F Cold Test. |
| 9/10/79 | 140.5 | Completed setup for -50°F cold test with the following items:<br>1. Set up to add JP4 fuel to the system when the DFA fuel is used up.<br>2. Obtained new fuel and oil samples.<br>3. Set up for maintaining auxilliary batteries at -25 with heaters built in. |
| | 140.6 | Completed run to dry the engine while cooling. |
| | 140.6 | Start of -50° Cold Test. Started 24 hour cold soak at 0920 o'clock. |
| 9/11/79 | 140.6 | Cold start was completed at -50° and the unit was loaded, within 1 minute to rated load (150 KW). The following chronological sequence ended in engine failure: |

| Time(Sec) | Event |
|---|---|
| 0 | Selected start. |
| .35 | Quick fill @ 180 ma. |
| 1 | Start of N1 increase. |
| 2 | Light-off to 400°F T4. |
| 2.4 | Off the quick fill to about 60 ma. |
| 7.6 | Start of rapid T4 rise from 450°F. |
| 14 | Start of MOP rise. If at 80 ma and starting to cut back—T4 at 1680°F. |
| 18.3 | Control oil press "pegged" at 500 psig +, MOP = 10 psig, If = 68 ma, N1 = 10,500 rpm, T4 = 1800°F. |
| 20.7 | Control oil press below 500 psig. |
| 21.4 | Start of increase in N2. |
| 38.1 | Main oil press (MOP) = 130 psig at maximum point. |
| 40.0 | If cut back to zero--awaiting synchronous speeds. |
| 41.0 | Start of accel - N1 = 26,000 rpm, N2 = 2350 rpm. |

| Date | Gen Set Hrs. | Event Time(Sec) | Event |
|---|---|---|---|
| | | 43.0 | N2 = 3500, N1 = 40, 500, $I_f$ cut to zero. T4 decreasing, frequency = 449 Hz. |
| | | 46 | N1 back to 35,000 rpm, N2 back to 2650 rpm, start of clutch lock-up and increase in $I_f$. |
| | | 48.4 | 400 Hz steady, T4 = 970°F, clutch pressure = 130 psig, MOP = 100 psig, control oil press = 215 psig. |
| | | 60 | Load to 150 KW, .8 PF., Max T4 = 1550°F, 2 Hz dip in frequency, recovery to 403 Hz. |
| | | 70 | Temperature increase from 1400° to 1590° with slow speed decrease to 386 Hz - Howl from Unit. |
| | | 71.6 | 386 Hz starting to recover. |
| | | 74.4 | Recovered to 406 Hz, T4 dropped to 1400°F. |
| | | 76.2 | T4 increase to 1550°F with howl. Speed decreased to 398 Hz. |
| | | 78.7 | T4 dropped to 1450°F and speed recovered to 406 Hz. |
| | | 86 | Unit emitted a loud "pop." T4 went to 1920°F and unit was manually shut down. |

The generator set and engine were disassembled to assess the failure damage. The failure and secondary damage are shown on Photos 351421 through 351439 and 351525.

Photographs 351430 and 351432 picture the failed power turbine roller bearing which was apparently the primary failure due to lack of lubrication. The other photographs depict secondary damage but special interest should be taken in the gasifier front (Photo 351429) and rear (Photo 351427) ball bearings which had extreme distress on one side due to the heavy activity at the quill shaft which finally failed at the seal (Photo 351424) which runs in the bushing located in the aft end of the power turbine (Photo 351426).

Following the replacement of parts, the engine was repaired and was check run on test stand 887. Several problems and significant events ensued as follows:

| Date | Engine Hours | Event |
|---|---|---|
| 9/17/79 | 185.6 | Had to rework compressor cover pilot (.006 inch too small) to install the inlet adapter. Start flow checks--40 and 66 cc's. |
| | 185.8 | Obtained vibration signatures which showed predominantly 50 Hz (output rotational) and 2500-3150 Hz (output gear tooth mesh frequency). All levels were within limits (AD5210-00006 thru 00008). |
| | 185.9/186.5 | Had two magnetic drain plug indications. Plugs were cleaned of fuzz. |
| 9/18/79 | 190.0 | Replaced the P/N 23000974 gasifier oil transfer cap to stop an air leak at the flange. Flange was on the old one. |
| | 191.7 | Discovered T4 thermocouple guide tubes were not in the proper positions. Reinstalled them properly. |
| | 193.7 | Completed engine check out. See "Test Results." |

During the engine repair and test period, this buildup, stiffeners were installed in the generator set control console. The engine was reinstalled in the generator set, and on September 20, 1979, the generator set (S/N 0000003, Buildup #6) was reinstalled on Test Stand 873 for a final checkout prior to shipment to the Army. The unit was checked out through the speed and power range, paralleling systems were checked, load sensing was checked at 3.0 volts and the Delco monitor was checked (minor adjustments) for agreement with the standard instrument. The exhaust covers were installed and functionally checked. Following the generator set final checkout, a shaker test was conducted indicating that the added stiffeners had significantly reduced the 50 Hz vibration in the wiring panel and adjacent control console components. (See ETR 79D65.)

The generator set S/N 0000003 was prepared for shipment (including repainting) and, on September 24, the unit was shipped to MERADCOM Ft. Belfoir, VA. The following additional items were included in the shipment: (The unit oil and fuel systems were full, the batteries disconnected and circuit breaker open.)

1. One box of extraneous load bank instrumentation parts.

2. Exhaust (engine and generator) ducts and supporting structure.

3. Load bank that had been used for extra loading on this test and for all QC tests.

Test Results

Prior to the start of the environmental tests, several of the required tests were run to check the unit and test techniques at ambient conditions.

The Indicating Instrument test – PD#27 (513.1) data, tabulated on Addendum A, pages 1 and 2 indicated phase to phase voltages were out of limits at the following conditions:

1. Phase 2-3 with 75 percent load at 388 Hz and 400 Hz frequency.

2. Phase 3-1 with 75 percent load at 388 Hz, 400 Hz, and 412 Hz.

3. Phase 2-3 with 100 percent load at 388 Hz.

4. Phase 3-1 with 50 percent load at 388 Hz.

5. At 100 percent load and 412 Hz frequency, gen set data were not taken.

The Battery Charging test at ambient conditions per paragraph 4.4.1 was completed and the results are plotted on Enclosure AD5210-00009. These curves indicate good regulation from minimum current to over 60 amps with about 0.2 volts drop at the higher loads. (See results of test after D.C. control test.).

The D.C. control test was attempted three times. On the first two tests, the reverse polarity test resulted in a failed reverse polarity system diode. On the third test, the reverse polarity test was deleted and the remaining results were as follows:

1. There were no apparent operational problems resulting from disconnecting the batteries.

2. There were no voltage spikes (on the oscillograph voltage records) at any time.

3. With 28.4 initial DC volts, the following changes occurred when the batteries were disconnected:

   3.1 T4 temperature decreased from 1690°F to 1659°F apparently due to dropping the battery charging load.

   3.2 DC voltage increased from 28.4 volts to 31.6 volts for the same reason (See Battery Charging Test below.)

   3.3 Exciter current increased from 2.287 amps to 2.322 while exciter voltage increased from 7.047 to 7.212 volts.

   3.4 Frequency, load, AC voltages, AC currents and other parameters did not change significantly.

   3.5 Voltage and frequency bandwidths remained well below limits at 0.2 and 0.1 percent respectively.

4. With 25.9 initial voltage setting, the following changes resulted from disconnecting batteries:

   4.1 T4 temperature dropped from 1652°F to 1640°F.

   4.2 DC control voltage increased from 25.9 to 28.0 volts.

   4.3 DC current dropped from 4.4 amps to 4.0 amps--reason unknown.

   4.4 Exciter current increased (2.263 to 2.318 amps) while exciter voltage increased (7.120 to 7.429 volts).

   4.5 No other parameters showed significant change.

   4.6 Bandwidths remained at about 0.2 and 0.1 percent for voltage and frequency respectively.

5. The test was not run at max voltage because of the concern that the reverse polarity system diode would be affected.

Because of discrepancies in load, no-load voltage during the battery charging and DC Control tests above, the Battery Charging test was rerun and plotted on Enclosure AD5210-00010. These results indicate about 1.5 volts drop from no load to loaded (60 amp) condition. The reason for the discrepancy is unexplained unless the reverse polarity diode failures affected the alternator or its regulator.

The data for the Frequency Adjust testing at ambient pressure and +125°F temperature per MIL STD 705B, method 511.2 are tabulated on Addendum B, page 1. These data indicate that the +3 percent limit could not be reached (411 Hz max) and the unit shut down with a T6 overtemperature shutdown when frequency was reduced to 396 Hz with 150 KW load. The no load testing was acceptable except 411 Hz was maximum frequency attainable.

The test results of the Regulator Range test, at +125°F, per PD#29 (511.1), are tabulated on Addendum B page 2. The data from the Standard Instrument indicated regulation was well within the one (1) percent limit. The Texas Instruments (T.I.) recorder appeared to have some hysteresis; and thusly, results from it indicated regulation in the 1.91 to 2.72 percent range. This discrepancy was not resolved.

The test data from the Indicating Instrument test at +125°F temperature per PD#27 (513.1) are shown on pages 3 and 4 of Addendum B. These data indicate good agreement between the generator set instruments and the "standard" with only one voltage (3-1 phase at 400 Hz) out of limits. The 100 percent load at 388 Hz could not be run.

The data from the Frequency and Voltage Regulation, Stability, and Transient Response Test at +125°F per PD17 (608.1) are shown on pages 5 and 6 of Addendum B. These data indicate that the frequency overshoots and recovery times were out of limits at 75 and 100 percent load. This is as expected, and the prototype units are not required to meet these limits. In addition, the voltage regulation was out of limits at all load changes except 25 percent. These data were transient, taken from the T.I. recorder. (See the discussion on Regulator Range test, above, for further information on regulation.)

Though eliminated in the Test Request, the overload relay test per PD paragraph 3.10.3.3 was requested at 125°F; and this relay, as expected, failed to meet the Purchase Description (PD) paragraph 3.10.3.3 requirements. The time results were as follows:

| Phase | *Load | Operating Time |
|---|---|---|
| 3(C) | 200% | 1:12, 1:27, 1:27 (Min:Sec) |
| | 130% | > 10 minutes |
| 2(B) | 200% | 1:27, 1:14, 1:14 (Min:Sec) |
| | 130% | >10 Minutes |
| 1(A) | 200% | 1:14, 1:12, 1:13 (Min:Sec) |
| | 130% | >10 Minutes |

| Phase | *Load | Operating Time |
|---|---|---|
| 1,2&3 | 110% | No load release in 2 hours. |

*The overload was simulated to the relay by using special current transformers on the load lines.

When the relay is set to operate in the 8±2 minutes at 130 percent load, it will release the load when running for long periods at 100% load (150 KW).

The data from the long term frequency and voltage stability test, at 125°F, per PD#20 (608.2), tabulated on Addendum B, page 7, indicate a maximum long term bandwidth of .56 volts or .47 percent of rated phase-to-neutral voltage (120V). This is within the required limits.

The data from the DC control test at 125°F per PD#37, MIL-STD-705B, method 655.1, did not indicate any operating difficulties (except those described in Test History due to diode problems) or any voltage spikes during operation with, or without batteries connected. Incomplete hand data prevented analysis of the DC current and voltage relationships during this test.

On the run, shutdown, and restart test per MIL STD 705B, method 710.1, the unit completed the test without any difficulties. As expected, the shutdown, from rated load condition, caused more severe overspeed due to the high residual temperature in the regenerators. This overspeed reached about (off the chart scale) 460 Hz or 115 percent speed. The restart required about 23.7 seconds to reach 100 percent speed.

The circuits interrupter-overvoltage and undervoltage test, at 125°F, per PD#26 (512.3), provided the following operating times:

1. Overvoltage step applications from 208 volts to 271-272 volts resulted in the overvoltage relay opening at .170, .182 and .171 seconds on three tests. Two of these are slightly faster than the .20±.02 second limits.

2. Undervoltage steps from 208 volts to 161 volts resulted in the main circuit interrupter (CB5) opening after 2.840, 2.840 and 2.843 seconds on three (3) tests. These values were within the 3±1 second limit.

Enclosure AD5210-00011 contains the data from the battery charging test at 125°F per PD paragraph 4.4.1. The battery charging alternator was damaged during the test and was replaced before the minimum voltage portion of the test. As may be seen from the enclosure, the minimum voltage adjustable was 27.9 volts at 3 amps. The curve for the minimum voltage setting on the replacement alternator did not have the same characteristics as the unit that had been damaged. A short time short circuit was applied across the alternator without damage. Current limiting was not checked.

Page 8 of Addendum B contains the data from the voltage dip and rise test at 125°F per PD#24 (619.2). These data show that all voltage dips and rises were within the 15 percent limit, but the percent rise values, during load dump, were as high as 14.9 percent, which is very marginal. Recovery times were very fast with a maximum time of .0925 seconds which is .26 percent of the .35 second limit.

Enclosures AD5210-00012 and AD5210-00013 contain the basic engine and gen set parameters during the voltage and frequency drift test per PD#19 and paragraph 4.4.5. This test was run with end points at 81°F and 21°F. The data from the above referenced enclosures show the following:

1. Power, regulated voltage, oil temperature, generator cooling air differential temperature ($\Delta T$) and generator set cooling air differential temperature experienced only minor changes.

2. T4 dropped from about 1670°F to about 1440°F or 3.83 degrees for each degree reduction in inlet temperature.

3. Frequency increased about 1.7 Hz (.43%) while the generator set instrument indicated a decrease of 2 Hz (0.5%). The allowable limit for drift was 3.0 percent.

4. Engine exhaust temperature decreased from 545°F to 470°F or 1.25°F per degree of inlet temperature change.

5. Exciter voltage decreased 1.16 volts (15.83%).

6. Exciter current decreased .10 amps (4.35%).

Page one (1) of Addendum C comprises the test results of the regulator range test at 5,000 ft. altitude and 107°F per PD#29 (511.1). These data again show the regulation, based on data from the Standard Instrument, is well below limits with a maximum value (at 219 volts) of 0.71 percent. The T.I. recorder indicates a maximum regulation error of 2.40 percent at 197 volts.

The test results from the frequency and voltage regulation, stability and transient response test at 5,000 ft. altitude and 107°F per PD#17 (608.1) are tabulated on pages 2 and 3 of Addendum C. These data indicate the following parameters were out of limits:

1. Unload overshoot on frequency at 75 and 100 percent load dumps.

2. Unload recovery time on frequency at all loads but 25 percent.

3. Load recovery time on frequency at 100 percent load.

4. Voltage regulation during all load changes except 25 percent load. Note the differences in instruments reported in discussion of voltage regulator range test above.

5. Unload recovery time on voltage from 100 percent load.

Addendum C (pages 4 and 5) contains the results of the Indicating Instrument test, at 5,000 ft. and 107°F per PD#27 (513.1). The instruments in the generator set were within limits compared with the Standard Instrument except for readout of voltage as follows:

1. Phase 3-1 voltage at all tested speeds with 75 and 100 percent load were out of limits.

2. Phase 1-2 voltage was out of limits at 75 percent load and 388 Hz.

3. Phase 2-3 voltage was out of limits at 100 percent load with 400 and 412 Hz speeds.

In addition, the rated load, 288 Hz condition could not be run because of high operating temperatures.

Testing at 8,000 feet altitude and 95°F was initiated 7/20/79 and completed 7/21/79. The test results from the Indicating Instrument test at 8,000 Ft. and 95°F per PD#27 (513.1) are tabulated on pages 1 and 2 of Addendum D. Again, the rated power (138 KW could not be run at 388 Hz due to high T6 temperatures. The remaining data indicate that the gen set instruments agreed with the Standard Instrument except on voltage phase 3-1 at all speeds with 75 percent and rated load and phase 2-3 voltage at both speeds with rated load.

NOTE: In all tests at 8,000 ft. and 95°F, where rated load is 137.5 KW, the part power points were run at 25, 50 or 75 percent of 150 KW.

The test results of the regulator range test at 8,000 ft. altitude and 95°F per PD#29 (511.1) are displayed on page 3 of Addendum D. As in the tests at other conditions, the data from the Standard Instrument indicate all regulation is well within the 1 percent limit (.35 percent max at 197 volts) while the T.I. recorder indicates values as high as 2.18 percent.

The attached pages 4 and 5 of Addendum D contain the test results of the frequency and voltage regulation, stability and transient response test at 8,000 ft. and 95°F per PD#17 (608.1). The following conditions were out of limits (this prototype unit is not contractually required to meet frequency overshoot, undershoot and recovery times):

1. Frequency overshoot was out of limits when unloading from 75 percent or rated load (138 KW).

2. Frequency recovery time was out of limits for 50 and 75 percent loads and for rated load (138 KW).

3. Voltage regulation, based on the T.I. recorder data, was out of limits at 75 percent and rated (138 KW) load.

The overtemperature safety device test at 125°F per PD#40 (515.2A) resulted in 174 KW and 2020°F T4 at the time of the overtemperature shutdown. The engine actually decelerated along an acceleration fuel schedule until an underfrequency relay trip dropped the load. At about this same time, the O.T. shutdown occurred.

The gasifier pinion bearing failure and the various problems during the early start attempts at -25°F chamber soak temperatures are documented in the Test History. The special tests resumed 9/7/79 on the -25°F cold test.

The fire-up and loading to 150 KW within one minute with -25°F temperatures did not present any problem following the installation of the clutch cooling oil reduction plug.

The first special test at -25°F was the regulator range test per PD#29. Addendum E, page 1 contains the results of this test at -25°F per PD#29 (511.1). As in the other regulator range tests, the data from the Standard Instrument and the T.I. recorder disagree. The unit meets all requirements based on data from the "Standard Instrument" which measured a maximum regulation of .260 percent at 197 volts.

Addendum E pages 2 and 3 show the results of the frequency and voltage regulation, stability and transient response test at -25°F per PD#17 (608.1). These data indicate that the only parameter out of limits was voltage regulation, based on the T.I. recorder results.

On the Indicating Instrument test, at -25°F, per PD#27 (513.1), the phase 3-1 voltage was out of limits at all conditions except 388 and 412 Hz with zero load. All voltage readings were out of limits at 100 percent load and phase 2-3 voltage was out of limits at zero load. These data are tabulated on pages 4 and 5 of Addendum E.

The remaining environmental testing through the engine failure on the -50° cold test are reported in Test History. The engine performance, during the check run, is plotted on Enclosure AD5210-00014.

All line recordings and hand data are filed with the test folders under EDO5210-01, P568-06.

# ADDENDUM E
## -25°F COLD TEST



### 511.1 REGULATOR RANGE TEST @ -25°F

208 V STANDARD = $\frac{121.8 - 121.5}{1.215} = 0.247\%$

TI RECORDER = $\frac{122.0 - 119}{1.215} = 2.52\%$

219 V STANDARD = $\frac{127.5 - 127.2}{1.272} = 0.236\%$

TI RECORDER = $\frac{128 - 125.2}{1.252} = 2.24\%$

242 V STANDARD = $\frac{141.1 - 140.8}{1.408} = 0.213\%$

TI RECORDER = $\frac{141 - 139}{1.39} = 1.44\%$

197 V STANDARD = $\frac{115.5 - 115.2}{1.152} = 0.260\%$

TI RECORDER = $\frac{115.7 - 113.}{1.13} = 2.39\%$

MIN VOLTAGE 106.4 V.

# ADDENDUM E
## -25° COLD TEST



17 608.1 FREQUENCY AND VOLTAGE REGULATION STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| LIMITS | BAND WIDTH @ LOAD | .5% | 1.% |
| | NO LOAD | .5% | 1% |
| * NEGLIGIBLE | REGULATION | .5% | 1% |
| | UNLOAD OVER SHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| | LOAD UNDERSHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1SEC | .35 SEC |
| FULL LOAD RDGS | | | |
| | BAND WIDTH @ LOAD | *NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .038% | (1.83%) |
| | UNLOAD OVERSHOOT | .75% | 3.50% |
| | RECOVERY TIME | .51SEC | .24SEC |
| | LOAD UNDERSHOOT | .475% | 1.17% |
| | RECOVERY TIME | .69SEC | .24SEC |
| 3/4 LOAD READINGS | | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .025% | (1.75%) |
| | UNLOAD OVERSHOOT | .31% | 2.50% |
| | RECOVERY TIME | .24SEC | .27SEC |
| | LOAD UNDERSHOOT | .24% | NEG |
| | RECOVERY TIME | .18SEC | NEG |
| 1/2 LOAD READINGS | | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .025% | (1.33%) |
| | UNLOAD OVERSHOOT | NEG | NEG |
| | RECOVERY TIME | NEG | NEG |
| | LOAD UNDERSHOOT | .075% | NEG |
| | RECOVERY TIME | NEG. | NEG |

# ADDENDUM E



## -25°F COLD TEST

17 (CONT.) 608.1 FREQUENCY AND VOLTAGE REGULATION, STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| 1/4 LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | | .67% |
| | UNLOAD OVERSHOOT | | NEG |
| | RECOVERY TIME | | |
| | LOAD UNDERSHOOT | | |
| | RECOVERY TIME | | |
| FULL LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG. |
| | REGULATION | .025% | 2.33% |
| | UNLOAD OVERSHOOT | .65% | 3.0% |
| | RECOVERY TIME | .45SEC | .24SEC |
| | LOAD UNDERSHOOT | .475% | 1.0% |
| | RECOVERY TIME | .69SEC | .21SEC. |

# ADDENDUM E

Page 4

## - 25°F COLD TEST

27 513.1 PANEL INSTRUMENTATION

| | INSTRUMENT ERROR @ 388 Hz | @ 400 Hz | @ 412 Hz | LIMIT |
|---|---|---|---|---|
| ZERO LOAD - KW | +2. | +2. | +1. | — |
| FREQUENCY | +.6 | +.7 | -.1 | ±3 Hz |
| VOLTAGE 1-2 | -1.3 | -1.6 | -1.3 | ±1.56V |
| 2-3 | -.8 | (-1.7) | -1.2 | ±1.56V |
| 3-1 | -1.4 | (-1.8) | -1.4 | ±1.56V |
| CURRENT 1 | +1. | 0 | +1. | ±10.4A |
| 2 | +1. | 0 | 0 | ±10.4A |
| 3 | +1. | 0 | +1. | ±10.4A |
| 25% LOAD-KW | +2.3 | +2.3 | +0.1 | — |
| FREQUENCY | +1.7 | +.9 | +2.4 | ±3 Hz |
| VOLTAGE 1-2 | -1.5 | -1.4 | -1.5 | ±1.56V |
| 2-3 | -.6 | -.6 | -.6 | ±1.56V |
| 3-1 | (-1.8) | (-1.8) | (-1.8) | ±1.56V |
| CURRENT 1 | -1.2 | -2.4 | -1.6 | ±10.4A |
| 2 | +.5 | +.6 | +.4 | ±10.4A |
| 3 | -.3 | -.7 | -.2 | ±10.4A |
| 50% LOAD-KW | +3.3 | +3.4 | +3.6 | — |
| FREQUENCY | +1.2 | +.8 | -.1 | ±3 Hz |
| VOLTAGE 1-2 | -1.5 | -1.4 | -1.4 | ±1.56V |
| 2-3 | +.1 | -.8 | +.2 | ±1.56V |
| 3-1 | (-2.1) | (-3.0) | (-2.0) | ±1.56V |
| CURRENT 1 | -1.7 | -1.2 | -1.2 | ±10.4A |
| 2 | +2.5 | +2.8 | +3.4 | ±10.4A |
| 3 | -1.6 | -.8 | -.3 | ±10.4A |

# ADDENDUM E



## -25°F COLD TEST

| | INSTRUMENT ERROR @388 Hz | @400 Hz | @412 Hz | LIMIT |
|---|---|---|---|---|
| 75% LOAD-KW | +1.8 | +1.7 | +1.8 | — |
| FREQUENCY | +.2 | 0 | -.3 | ±3 Hz |
| VOLTAGE 1-2 | -1.3 | -1.2 | -1.1 | ±1.56V |
| 2-3 | -.8 | -.7 | -.6 | ±1.56V |
| 3-1 | (-3.0) | (-2.9) | (-2.8) | ±1.56V |
| CURRENT 1 | -2.6 | -3. | -3.2 | ±10.4A |
| 2 | +3.4 | +3.6 | +3.9 | ±10.4A |
| 3 | -1.9 | -.2 | -1.0 | ±10.4A |
| 100% LOAD-KW | +3.8 | +3.2 | +3.7 | — |
| FREQUENCY | -.4 | -.9 | -.1 | ±3Hz |
| VOLTAGE 1-2 | (-1.9) | (-1.9) | (-1.8) | ±1.56V |
| 2-3 | (-3.8) | (-1.7) | (-1.6) | ±1.56V |
| 3-1 | (-2.8) | (-1.9) | (-2.6) | ±1.56V |
| CURRENT 1 | -4.8 | -5. | -4. | ±10.4A |
| 2 | +4.2 | +4.3 | +3.7 | ±10.4A |
| 3 | -1.9 | -2. | -2.1 | ±10.4A |

# ADDENDUM F



SUBJECT

PREPARED BY H-GASTON

DATE 11/6/79 DEPT NO. 5870

## INSTRUMENTATION LIST

| PARAMETER | INSTRUMENT NAME | TYPE | MODEL | SERIAL | LAST CAL | CAL. REQD | |
|---|---|---|---|---|---|---|---|
| KILOWATTS | ROCKWELL ENGR GENERATOR MONITOR | DIGITAL | 034027 | 78041 | 3/18/79 | 3/18/80 | |
| KILOVARS | " | " | " | " | " | " | |
| A.C. VOLTS (L) | " | " | " | " | " | " | |
| A.C. CURRENT (3) | " | " | " | " | " | " | |
| D.C. CURRENT | " | " | " | " | " | " | |
| D.C. VOLTAGE | " | " | " | " | " | " | |
| FREQUENCY | ATEC COUNTER | " | 2300 | GDB715 | 5/10/79 | 11/10/79 | |
| T4 TEMP | TRENDICATOR | DIGITAL | 400 A | 55475 | 6/29/79 | 12/29/79 | |
| VIBRATION 1 | C.E.C. | METER | 117 | 4009 | 3/24/79 7/19/79 | 7/21/79 11/22/79 | PICKUP V118 CF .949, 5/20/79 |
| 2 | C.E.C. | " | 117 | " | " | " | P.U. H268 CF .917 6/6/79 |
| 3 | C.E.C. | " | 117 | 4129 | 6/26/79 | 10/26/79 | P.U. H217 CF .897 6/6/79 |
| ALTERNATER CURRENT | FLUKE | DIGITAL | 8000A | 000171 | 3/18/79 | 9/18/79 | |
| ALTERNATER VOLTAGE | " | " | " | 000171 | " | " | |
| TEST CELL AIR TEMP #1 | DORIC | CA " | DS 300 | 62089 | 6/29/79 | 12/29/79 | |
| #2 | " | " | " | " | " | " | |
| #3 | " | " | " | " | " | " | |
| #4 | " | " | " | " | " | " | |
| TEST CELL OIL BATH TEMP #1 | " | " | " | " | " | " | |
| #2 | " | " | " | " | " | " | |

# ADDENDUM F

SUBJECT

PREPARED BY H. GASTON

DATE 11/6/79 DEPT NO. 5870

## INSTRUMENTATION LIST

| PARAMETER | INSTRUMENT NAME | TYPE | MODEL | SERIAL | LAST CAL | CAL REQ'D |
|---|---|---|---|---|---|---|
| TEST CELL OIL BATH #3 | DORIC | CA DIGITAL | DS300 | 62089 | 6/29/79 | 6/29/79 |
| #4 | " | CA " | " | " | " | " |
| OIL IN TEMP | " | " " | " | " | " | " |
| OIL SUMP TEMP | " | " " | " | " | " | " |
| BATTERY ELECTROLYTE (1) | " | " " | " | " | " | " |
| (2) | " | " " | " | " | " | " |
| (3) | " | " " | " | " | " | " |
| (4) | " | " " | " | " | " | " |
| ENGINE LH. EXH. TEMP | " | " " | " | " | " | " |
| RH. | " | " " | " | " | " | " |
| GEN COOLING AIR IN. | " | " " | " | " | " | " |
| GEN COOLING AIR OUT | " | " " | " | " | " | " |
| CONTROL CABINET TEMP | " | " " | " | " | " | " |
| GEN STATOR TOP TEMP | " | " " | " | " | " | " |
| GEN STATOR BOTTOM TEMP | " | " " | " | " | " | " |
| ENCLOSURE IN TEMP | " | " " | " | " | " | " |
| ENCLOSURE OUT TEMP | " | " " | " | " | " | " |
| DAY TANK FUEL TEMP | " | " " | " | " | " | " |
| EXCITER STATOR TEMP | " | " " | " | " | " | " |

# ADDENDUM F

SUBJECT

PREPARED BY H. GASTON

DATE 11/6/79 | DEPT NO. 5870

## INSTRUMENTATION LIST

| PARAMETER | INSTRUMENT NAME | TYPE | MODEL | SERIAL | LAST CAL | RECAL DATE | |
|---|---|---|---|---|---|---|---|
| ENGINE AIR IN TEMP LH | DORIC | CA DIGITAL | DS 300 | 62089 | 6/29/79 | 12/29/79 | |
| ENGINE AIR IN TEMP R.H. | " | " " | " | " | | | |
| WOODWARD CONTROL TEMP | " | " " | " | " | | | |
| FUEL SUPPLY TEMP | HONEYWELL BROWN | IC POTENTIOMETER | — | 944446 | 6/29/79 | 10/29/79 | |
| THE FOLLOWING PARAMETERS WERE RECORDED FOR DDAD INFORMATION. (NOT ALL RECORDED SIMULTANEOUSLY) | | | | | | | |
| Gasifier Speed | GOULD BROWN | LINE RECORDER | 156617 | Y10026 → Y10025 | 3/15/79 → 9/6/79 | 9/15/79 → 3/6/80 | |
| OUTPUT SPEED | " " | " | " | " " | " " | " " | |
| T4 TEMP | " " | " | " | " " | " " | " " | |
| MAIN OIL PRESSURE | " " | " | " | " " | " " | " " | SEE TRANSDUCER |
| CLUTCH OIL PRESSURE | " " | " | " | " " | " " | " " | SEE TRANSDUCER |
| CONTROL OIL PRESSURE | " " | " | " | " " | " " | " " | SEE TRANSDUCER |
| CLUTCH VALVE CURRENT | " " | " | " | " " | " " | " " | |
| FUEL VALVE CURRENT | " " | " | " | " " | " " | " " | |
| FREQUENCY | " " | " | " | " " | " " | " " | |
| MAIN OIL PRESSURE | DYNISCO | STRAIN GAGE TRANSDUCER | PT310 | 028701 | 6/24/79 | 12/24/79 | |
| CLUTCH OIL PRESSURE | " | " | BLH-DHF | 028752 | 6/24/79 | 12/24/79 | |
| CONTROL OIL PRESSURE | " | " | BLH-DHF | 028729 | 6/24/79 | 12/29/79 | |

# ADDENDUM F



SUBJECT

PREPARED BY H. GASTON

DATE 11/6/79 | DEPT NO. 5870

## INSTRUMENTATION LIST

| PARAMETER | INSTRUMENT NAME | TYPE | MODEL | SERIAL | LAST CAL | RECAL REQUIRED | |
|---|---|---|---|---|---|---|---|
| FREQUENCY PHASE B-N AC VOLTAGE | TEXAS INSTRUMENTS | 2 CHANNEL RECORDER | PDR HXF-HXVA -A16-XT | 3511 | 5/21/79 | 11/21/79 | |
| " | " | " | " | " | " | " | |
| AC VOLTAGE 1-2 | HONEYWELL VISICORDER | OSCILLOGRAPH | 1558 | X-10017 | 5/23/79 | 11/23/79 | USED FOR O.V., |
| " 2-3 | " | " | " | " | " | " | U.V., VOLTAGE DIPS |
| " 3-1 | " | " | " | " | " | " | RISE TESTS |
| AC CURRENT 3-1 | " | " | " | " | " | " | |
| INLET AIR PRESS | MANOMETER | INCH MERCURY | MM 153 | C153112 | 6/28/79 | | MANOMETERS PR TESTED 6/28/79. |
| EXH GAS PRESS LH | " | " " | " | 153114 | " | | BAROMETER SET |
| " RH | " | " " | " | 153118 | " | | UPON HOUR. |

# ADDENDUM A
## Ambient Inlet Conditions

27 513.1 PANEL INSTRUMENTATION

| | INSTRUMENT ERROR @ 288 Hz | @ 400 Hz | @ 1000 Hz | LIMIT |
|---|---|---|---|---|
| ZERO LOAD - KW | +1.9 | +1.9 | +1.9 | — |
| FREQUENCY | +2 | +2 | +2 | ±3 Hz |
| VOLTAGE 1-2 | -0.6 | -0.6 | -0.6 | ±1.56V |
| 2-3 | -0.6 | -0.6 | -0.5 | ±1.56V |
| 3-1 | +0.3 | +0.3 | +0.2 | ±1.56V |
| CURRENT 1 | +2 | +2 | +1 | ±10.4A |
| 2 | +2 | +2 | +1 | ±10.4A |
| 3 | +2 | +2 | +1 | ±10.4A |
| 25% LOAD-KW | +3 | +3 | +3.1 | — |
| FREQUENCY | +2 | +1 | +1 | ±3 Hz |
| VOLTAGE 1-2 | -0.3 | -0.7 | -0.3 | ±1.56V |
| 2-3 | -0.4 | -0.3 | -0.4 | ±1.56V |
| 3-1 | -0.7 | -0.6 | -0.7 | ±1.56V |
| CURRENT 1 | -0.5 | -0.8 | -1 | ±10.4A |
| 2 | +1.2 | +2.1 | +2.1 | ±10.4A |
| 3 | +0.2 | -0.2 | -0.4 | ±10.4A |
| 50% LOAD-KW | +3.7 | +3.8 | +3.9 | — |
| FREQUENCY | +2 | 0 | +1 | ±3 Hz |
| VOLTAGE 1-2 | -0.4 | -0.4 | -0.3 | ±1.56V |
| 2-3 | +1.2 | +0.2 | -0.2 | ±1.56V |
| 3-1 | -1.8 | -0.8 | +0.3 | ±1.56V |
| CURRENT 1 | -1.1 | -1.2 | -0.6 | ±10.4A |
| 2 | +4.1 | +3 | +3.9 | ±10.4A |
| 3 | -0.1 | -0.8 | -0.2 | ±10.4A |

# ADDENDUM A
## Ambient Inlet Conditions



| | INSTRUMENT ERROR @388Hz | @400Hz | @412Hz | LIMIT |
|---|---|---|---|---|
| 75% LOAD-KW | +2.8 | +3 | +3.3 | — |
| FREQUENCY | +2 | +2 | +1 | ±3 Hz |
| VOLTAGE 1-2 | -0.6 | -0.5 | -0.4 | ±1.56V |
| 2-3 | +1.7 | +1.7 | +0.9 | ±1.56V |
| 3-1 | -1.7 | -1.8 | -1.6 | ±1.56V |
| CURRENT 1 | -2.6 | -2.2 | -2.7 | ±10.4A |
| 2 | +4.8 | +4.7 | +5 | ±10.4A |
| 3 | -0.6 | +0.1 | -03 | ±10.4A |
| 100% LOAD-KW | +1.5 | +29 | — | — |
| FREQUENCY | +2 | +2 | — | ±3Hz |
| VOLTAGE 1-2 | -0.2 | -0.1 | — | ±1.56V |
| 2-3 | -4.7? | +1.1 | — | ±1.56V |
| 3-1 | -0.9 | -0.8 | — | ±1.56V |
| CURRENT 1 | -3.7 | -2.8 | — | ±10.4A |
| 2 | +5.6 | +6 | — | ±10.4A |
| 3 | -1.2 | -09 | — | ±10.4A |

+125°F OFFICIAL TEST,

1. FREQUENCY ADJUST TEST. RESULTS. (511.2) - 150 KW

BRUSH - STABILIZED 399 Hz, 1900 - 1950 °T4 IND
MAX SPEED 409 Hz, ≈ 1850 °T4.
MIN SPEED 394 Hz, 2000 ° MAX T4.
T6 SHUT DOWN

T.I - STABILIZED 400.2 Hz, ≈122 V C-N.
MAX SPEED 411.3 Hz, ≈122 V C-N
MIN SPEED 396 Hz - ≈122 V C-N.
T6 SHUT DOWN.

| MASTER INSTRUMENT MANUAL DATA. | | SET |
|---|---|---|
| 400 Hz | RDG 148. | 402 Hz |
| 411 Hz | RDG 149. | 412 Hz |
| MIN | DATA NOT OBTAINED. | |

BECAUSE OF OVERTEMPERATURE INDICATIONS THE MINIMUM FREQUENCY PORTION COULD NOT BE COMPLETED AT 128°F CIT AND 150 KW 0.8 PF. ALSO - MAX ADJUSTMENT WAS 411 Hz INSTEAD OF DESIRED 412 Hz (+3%) PER P.D. 3.5.11.6. SEE INDICATING INSTRUMENT TEST, (METHOD 513.2) FOR ADDITIONAL FREQUENCY ADJUSTMENT TESTS AT ALL LOADS.

NO LOAD RESULTS.

BRUSH STABILIZED - 398 Hz
MAX SPEED - 409 Hz
MIN SPEED - 378 Hz
T.I STABILIZED - 401 Hz
MAX SPEED - 411.4 Hz
MIN SPEED - 382.2 Hz

| MASTER INSTRUMENT MANUAL DATA | | INSTR | SET |
|---|---|---|---|
| STABILIZED | RDG 154 | 400 Hz, | 402 Hz |
| MAX SPEED - | RDG 155 | 411 Hz, | 412 Hz |
| MIN SPEED - | RDG 156 | 380 Hz, | 382 Hz |

H. Gaston

# ADDENDUM 3

## REGULATOR RANGE TEST AT 125°F CIT (511.1).

1ST TEST ABORTED DUE TO BROKEN GROUND WIRE CAUSING UNDER VOLTAGE "DUMP".

LIMIT - 1% (P.D. 3.5.5)

208 V.

T.I RESULTS. $\frac{124.5 - 121.7}{121.2} = 2.72\%$.

MASTER. (RDG 168-169) $\frac{122.0 - 121.5}{121.5} = .41\%$.

≈ 219V.

T.I $\frac{131.3 - 128.8}{128.8} = 1.94\%$

MASTER (RDGS. 170-171) $\frac{128.2 - 127.8}{127.8} = .31\%$

≈ 242 V

T.I. $\frac{144 - 141.3}{141.3} = 1.91\%$

MASTER (RDG. 172-173) $\frac{140.7 - 140.3}{140.3} = 0.29\%$

≈ 197 V

T.I $\frac{118 - 115}{115} = 2.61\%$

MASTER (RDG 174-175) $\frac{115.7 \quad 115.3}{115.3} \quad 0.35\%$

MIN VOLTAGE - RDG 176.

T.I 108 V C-N,

MASTER NO READING.

# ADDENDUM B



## +125°F CONDITIONS

27 513.1 PANEL INSTRUMENTATION

| | INSTRUMENT ERROR @ 388 Hz | @ 400 Hz | @ 412 Hz | LIMIT |
|---|---|---|---|---|
| ZERO LOAD - KW | +2 | +2 | +2 | — |
| FREQUENCY | +2 | +2 | +1 | ±3 Hz |
| VOLTAGE 1-2 | -.3 | -.3 | -.3 | ±1.56V |
| 2-3 | -.2 | -.3 | -.2 | ±1.56V |
| 3-1 | -.4 | -.5 | -.5 | ±1.56V |
| CURRENT 1 | +1 | +1 | +1 | ±10.4A |
| 2 | +1 | +1 | +1 | ±10.4A |
| 3 | +1 | +1 | +1 | ±10.4A |
| 25% LOAD-KW | +2.8 | +2.8 | +2.3 | — |
| FREQUENCY | +2. | +1.5 | +1.0 | ±3 Hz |
| VOLTAGE 1-2 | +.1 | +.2 | 0 | ±1.56V |
| 2-3 | -.1 | 0 | 0 | ±1.56V |
| 3-1 | -.3 | -.3 | -.3 | ±1.56V |
| CURRENT 1 | -1.2 | -1.7 | -1.2 | ±10.4A |
| 2 | +1.1 | +1.0 | +1.8 | ±10.4A |
| 3 | -.6 | -.8 | -1.3 | ±10.4A |
| 50% LOAD-KW | +3.2 | +3.3 | +3.3 | — |
| FREQUENCY | +2. | +1. | +.5 | ±3 Hz |
| VOLTAGE 1-2 | +.1 | +.2 | +.2 | ±1.56V |
| 2-3 | +.6 | +.6 | +.6 | ±1.56V |
| 3-1 | -1.5 | -1.4 | -1.4 | ±1.56V |
| CURRENT 1 | -2.5 | -1.5 | -1.2 | ±10.4A |
| 2 | +3. | +2.9 | +3.0 | ±10.4A |
| 3 | -1.0 | -1.9 | -.2 | ±10.4A |

# ADDENDUM 3



27 513.1 PANEL INSTRUMENTATION @ +125°F

INSTRUMENT ERROR

| | @386 Hz | @400 Hz | @412 Hz | LIMIT |
|---|---|---|---|---|
| 75% LOAD-KW | +2.2 | +2.4 | +2.7 | — |
| FREQUENCY | +1.0 | 0 | +1. | ±3 Hz |
| VOLTAGE 1-2 | -0.6 | -0.2 | -0.2 | ±1.56 V |
| 2-3 | +1.1 | +1.1 | +1.2 | ±1.56 V |
| 3-1 | -1.4 | (-2.4) | -1.4 | ±1.56 V |
| CURRENT 1 | +.4 | -3. | -3.2 | ±10.4 A |
| 2 | +3.5 | +4.1 | +4.0 | ±10.4 A |
| 3 | -1.2 | -1.2 | -0.9 | ±10.4 A |
| 100% LOAD-KW | — | -4.3 | -4. | — |
| FREQUENCY | | +1. | +1. | ±3 Hz |
| VOLTAGE 1-2 | | -.3 | -.2 | ±1.56 V |
| 2-3 | NOT TESTED. | +1.2 | +1.2 | ±1.56 V |
| 3-1 | | -1.4 | -1.4 | ±1.56 V |
| CURRENT 1 | | -4.2 | -4.6 | ±10.4 A |
| 2 | | +5.3 | +4.7 | ±10.4 A |
| 3 | | -2.9 | -2.4 | ±10.4 A |

# ADDENDUM B



## +125°F CONDITIONS.

17 608.1 FREQUENCY AND VOLTAGE REGULATION, STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

NEG = NEGLIGIBLE.

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| LIMITS | BAND WIDTH @ LOAD | .5% | 1% |
| | NO LOAD | .5% | 1% |
| | REGULATION | .5% | 1% |
| | UNLOAD OVER SHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| | LOAD UNDERSHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| FULL LOAD RDGS | | | |
| | BAND WIDTH @ LOAD | .06% | NEG |
| | NO LOAD | .08% | NEG. |
| | REGULATION | .10% | 2.50% |
| | UNLOAD OVERSHOOT | 6.93% | 2.16% |
| | RECOVERY TIME | 6.18 SEC | .30 SEC |
| | LOAD UNDERSHOOT | 1.14% | 2.0% |
| | RECOVERY TIME | 2.82 SEC | .15 SEC. |
| 3/4 LOAD READINGS | | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .10% | 1.92% |
| | UNLOAD OVERSHOOT | 2.28% | 1.42% |
| | RECOVERY TIME | 3.24 SEC | .18 SEC |
| | LOAD UNDERSHOOT | .43% | .92% |
| | RECOVERY TIME | .72 SEC. | .18 SEC |
| 1/2 LOAD READINGS | | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .04% | 1.67% |
| | UNLOAD OVERSHOOT | .10% | 0 |
| | RECOVERY TIME | .15 SEC. | .09 SEC. |
| | LOAD UNDERSHOOT | .075% | 0 |
| | RECOVERY TIME | .15 SEC | .06 SEC |

# ADDENDUM B
## +25°F CONDITIONS



17 608.1 FREQUENCY AND VOLTAGE REGULATION, STABILITY AND TRANS. RESPONSE (MAX VALUES)

| | | | |
|---|---|---|---|
| 1/4 LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | 0. | .83% |
| | UNLOAD OVERSHOOT | 0 | 0 |
| | RECOVERY TIME | 0 | 0 |
| | LOAD UNDERSHOOT | 0 | 0 |
| | RECOVERY TIME | 0 | 0 |
| FULL LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG. | NEG. |
| | NO LOAD | .10% | NEG. |
| | REGULATION | .15% | 2.50% |
| | UNLOAD OVERSHOOT | 6.80% | 3.33% |
| | RECOVERY TIME | 6.12 SEC | .30 SEC |
| | LOAD UNDERSHOOT | 1.10% | 2.25% |
| | RECOVERY TIME | 1.98 SEC | .33 SEC. |

# ADDENDUM B
## 125°F CONDITIONS

60.2 LONG TERM FREQUENCY AND VOLTAGE STABILITY TEST

SHORT TERM-NO LOAD

TRACE WIDTH ≈ .015 WIDE OR $\frac{.015}{.445} \times 10 = .34$ VOLTS.

* MIN SHORT TERM = $120V + \frac{.220}{.445} \cdot 10 = 124.94$ V.

** MAX SHORT TERM = $120V + \frac{.240}{.445} \cdot 10 = 125.34$ V

DIFF = .45 V

− TRACE WIDTH .34 V

BAND WIDTH = .12 V

= .10%

* AT BOTTOM OF TRACE

** AT TOP OF TRACE.

LONG TERM-NO LOAD

* MIN LONG TERM = $120V + \frac{.220}{.445} \cdot 10 =$ 124.94 V.

** MAX LONG TERM = $120V + \frac{.260}{.445} \cdot 10 =$ 125.84 V

DIFF = .90 V

− TRACE WIDTH .34 V

BAND WIDTH = .56 V

= .47%

SHORT TERM-LOADED

* MIN-SHORT TERM = $120 + \frac{.075}{.445} \cdot 10 =$ 121.69 V

** MAX-SHORT TERM = $120 + \frac{.100}{.445} \cdot 10 =$ 122.25 V

DIFF = .56 V

− TRACE WIDTH .34 V

BAND WIDTH .22 V

= .18%

LONG TERM-LOADED

* MIN-LONG TERM = $120V + \frac{.075}{.445} \cdot 10 =$ 121.69 V

** MAX-LONG TERM = $120V + \frac{.105}{.445} \cdot 10 =$ 122.36 V

DIFF = 0.67 V

− TRACE WIDTH .34 V

BAND WIDTH = .33 V

= .28%

# ADDENDUM B
## 125 °F CONDITIONS

## VOLTAGE DIP DURING FULL LOAD APPLICATION

$V_{NL}$ - No Load Voltage before Loading.
$V_R$ = Rated Voltage
$V_L$ = Loaded Voltage after Loading
D = Min Peak-Peak Amplitude during Transient
L = Amplitude - Stabilized, Loaded
$V_D = D \cdot V_L / L$
$V_D\% = (V_{NL} - V_D) \cdot 100. / V_R$

| Memo Section | 5 | 7 | 9 | Avg. | Limits |
|---|---|---|---|---|---|
| $V_{NL}$ | 122.3 | 122.3 | 122.3 | 122.3 | |
| $V_R$ | 120. | 120. | 120. | 120.0 | |
| $V_L$ | 122.0 | 122.0 | 122.0 | 122.0 | |
| D | 2.59 | 2.62 | 2.62 | 2.61 | |
| L | 2.93 | 2.95 | 2.94 | 2.94 | |
| $V_D$ | 107.84 | 108.35 | 108.72 | 108.30 | |
| % $V_D$ | 12.05% | 11.62% | 11.32% | 11.66% | 15% |
| Recovery Time | .0675 sec | .0588 sec | .0563 sec | .0609 sec | 35 sec |

## VOLTAGE RISE DURING FULL LOAD DUMP

$V_{NL}$ - No Load Voltage after Transient
$V_R$ - Rated Voltage
$V_L$ - Loaded Voltage before Transient
R. - Max Peak-Peak Amplitude during Transient
NL - Amplitude - Stabilized, No Load.

| Memo Section | 4 | 6 | 8 | Avg | |
|---|---|---|---|---|---|
| $V_{NL}$ | 122.3 | 122.4 | 122.3 | 122.33 | |
| $V_R$ | 120. | 120. | 120 | 120.0 | |
| $V_L$ | 122.0 | 122.0 | 122.0 | 122.0 | |
| R | 3.37 | 3.36 | 3.35 | 3.36 | |
| NL | 2.97 | 2.94 | 2.95 | 2.953 | |
| $V_{RISE}$ | 138.77 | 139.89 | 138.88 | 139.18 | |
| % $V_{RISE}$ | +13.98% | 14.90% | 14.07% | 14.32% | 15% |
| Recovery Time | .091 sec | .0925 sec | .0925 sec | .0920 sec | .35 sec |

$V_{RISE} = (R \cdot V_{NL}) / NL$
$\%V_{RISE} = (V_{RISE} - V_L) \cdot 100 / V_R$

# ADDENDUM C

(511.1)

## REGULATOR RANGE TEST AT 5000 FT, 107°F.
LIMIT 1% (PD 3.5.5).

208 V

TI RESULTS = $\frac{122.0 - 119.5}{1.195}$ = 2.09%

MASTER DATA = $\frac{122.6 - 122.0}{1.220}$ = 0.49%

219 V

TI RESULTS = $\frac{128.0 - 125.8}{1.258}$ = 1.75%

MASTER DATA = $\frac{127.9 - 127.0}{1.270}$ = 0.71%

240 V

TI RESULTS = $\frac{141.2 - 139.0}{1.390}$ = 1.58%

MASTER DATA = $\frac{140.8 - 140.4}{1.404}$ = 0.28%

197 V

TI RESULTS = $\frac{115.3 - 112.6}{1.126}$ = 2.40%

MASTER DATA = $\frac{115.9 - 115.6}{1.156}$ = 0.26%

183 V
182.6

MIN VOLTAGE 183.4 VOLTS (TI)
106.7 VOLTS (MASTER)

# ADDENDUM C
## 5000 FT, 107°F



17 608.1 FREQUENCY AND VOLTAGE REGULATION STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

* NEGLIGIBLE

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| LIMITS | BAND WIDTH @ LOAD | .5% | 1% |
| | NO LOAD | .5% | 1% |
| | REGULATION | .5% | 1% |
| | UNLOAD OVERSHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| | LOAD UNDERSHOOT | 1.5% | 15.% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| FULL LOAD RDGS | | | |
| | BAND WIDTH @ LOAD | *NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | .125% | (2.0%) |
| | UNLOAD OVERSHOOT | (9.5%) | 3.33% |
| | RECOVERY TIME | (8.64 SEC) | .30 SEC |
| | LOAD UNDERSHOOT | .87% | 2.58% |
| | RECOVERY TIME | (1.62 SEC) | .15 SEC |
| 3/4 LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | .075% | NEG |
| | REGULATION | .05% | (1.75%) |
| | UNLOAD OVERSHOOT | (4.21%) | 1.67% |
| | RECOVERY TIME | (4.95 SEC) | .27 SEC |
| | LOAD UNDERSHOOT | .35% | .67% |
| | RECOVERY TIME | .60 SEC | .12 SEC |
| 1/2 LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG | NEG |
| | REGULATION | NEG | (1.50%) |
| | UNLOAD OVERSHOOT | .59% | NEG |
| | RECOVERY TIME | (1.35 SEC) | NEG |
| | LOAD UNDERSHOOT | .125% | NEG |
| | RECOVERY TIME | .09 SEC | NEG |

# ADDENDUM C
## 5000 FT, 107°F

17 (CONT.) 608.1 FREQUENCY AND VOLTAGE REGULATION, STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| 1/4 LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | *NEG | NEG |
| | NO LOAD | | NEG |
| | REGULATION | | .83% |
| | UNLOAD OVERSHOOT | | NEG |
| | RECOVERY TIME | | |
| | LOAD UNDERSHOOT | | |
| | RECOVERY TIME | | |
| FULL LOAD | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG. |
| | NO LOAD | .05% | NEG. |
| | REGULATION | .075% | 1.92% |
| | UNLOAD OVERSHOOT | 8.38% | 3.0% |
| | RECOVERY TIME | 8.40 SEC | .42 SEC |
| | LOAD UNDERSHOOT | .875% | 2.5% |
| | RECOVERY TIME | 1.65 SEC | .30 SEC |

* NEGLIGIBLE

# ADDENDUM C

## 5000 FT, 107°F

27 513.1 PANEL INSTRUMENTATION

| | INSTRUMENT ERROR @ 388 Hz | @ 400 Hz | @ 412 Hz | LIMIT |
|---|---|---|---|---|
| ZERO LOAD - KW | +7 | +7 | +7 | — |
| FREQUENCY | 0 | -3 | 0 | ±3 Hz |
| VOLTAGE 1-2 | -0.2 | -0.2 | -0.2 | ±1.56V |
| 2-3 | -0.2 | -0.2 | -0.3 | ±1.56V |
| 3-1 | -0.4 | -0.3 | -0.4 | ±1.56V |
| CURRENT 1 | +1 | +1 | +1 | ±10.4A |
| 2 | +1 | +2 | +1 | ±10.4A |
| 3 | +1 | +1 | +1 | ±10.4A |
| 25% LOAD-KW | +8.5 | +8 | +7.6 | — |
| FREQUENCY | 0 | 0 | 0 | ±3 Hz |
| VOLTAGE 1-2 | 0 | +0.1 | +0.1 | ±1.56V |
| 2-3 | -0.1 | 0 | -1.0 | ±1.56V |
| 3-1 | -1.3 | -1.3 | -1.3 | ±1.56V |
| CURRENT 1 | -0.9 | -1.2 | -0.7 | ±10.4A |
| 2 | +1.1 | +0.2 | +2.1 | ±10.4A |
| 3 | -0.4 | -0.7 | -1.1 | ±10.4A |
| 50% LOAD-KW | +5 | +39 | +5 | — |
| FREQUENCY | +1 | +1 | +1 | ±3 Hz |
| VOLTAGE 1-2 | +0.4 | +0.4 | +0.1 | ±1.56V |
| 2-3 | +0.9 | +0.7 | +0.7 | ±1.56V |
| 3-1 | -1.4 | -1.4 | -1.4 | ±1.56V |
| CURRENT 1 | -1.6 | -0.5 | -0.8 | ±10.4A |
| 2 | +2.7 | +3.2 | +4.1 | ±10.4A |
| 3 | -0.3 | +0.7 | +1.2 | ±10.4A |

# ADDENDUM C



5000 FT 107°F

| | INSTRUMENT ERROR @388 Hz | @400 Hz | @412 Hz | LIMIT |
|---|---|---|---|---|
| 75% LOAD-KW | +7.8 | +8.2 | +9.1 | — |
| FREQUENCY | +1 | +1 | 0 | ±3 Hz |
| VOLTAGE 1-2 | -1.8 | +0.1 | 0 | ±1.56V |
| 2-3 | +1.3 | +1.4 | +1.4 | ±1.56V |
| 3-1 | -2.4 | -2.3 | -2.6 | ±1.56V |
| CURRENT 1 | -2.1 | -2.2 | -2.1 | ±10.4A |
| 2 | +4.3 | +4.7 | +5.1 | ±10.4A |
| 3 | -1.6 | -1.3 | +0.3 | ±10.4A |
| 100% LOAD-KW | | -4.8 | +4.1 | — |
| FREQUENCY | | +1 | 0 | ±3 Hz |
| VOLTAGE 1-2 | | -0.8 | -0.7 | ±1.56V |
| 2-3 | | +1.8 | +1.7 | ±1.56V |
| 3-1 | | -2.3 | -2.1 | ±1.56V |
| CURRENT 1 | | -4.9 | -4.2 | ±10.4A |
| 2 | | +5.2 | +5.3 | ±10.4A |
| 3 | | -0.7 | -2.0 | ±10.4A |

# ADDENDUM D
## 8000 FT, 95°F

27 513.1 PANEL INSTRUMENTATION

| | INSTRUMENT ERROR @388Hz | @400Hz | @412Hz | LIMIT |
|---|---|---|---|---|
| ZERO LOAD - KW | +2 | +1 | +2 | — |
| FREQUENCY | 0 | -1 | -1 | ±3 Hz |
| VOLTAGE 1-2 | -0.5 | -0.5 | +0.4 | ±1.56V |
| 2-3 | -0.6 | -0.5 | -0.5 | ±1.56V |
| 3-1 | -0.7 | -0.7 | -0.8 | ±1.56V |
| CURRENT 1 | +2 | +1 | +1 | ±10.4A |
| 2 | +1 | +1 | +1 | ±10.4A |
| 3 | +1 | +1 | +1 | ±10.4A |
| 25% LOAD-KW | +5.3 | +4.4 | +5.5 | — |
| FREQUENCY | 0 | 0 | -1 | ±3 Hz |
| VOLTAGE 1-2 | -0.2 | -0.2 | -0.2 | ±1.56V |
| 2-3 | -0.3 | -0.3 | -0.4 | ±1.56V |
| 3-1 | -0.7 | -0.6 | -0.6 | ±1.56V |
| CURRENT 1 | -0.8 | -1.1 | -0.7 | ±10.4A |
| 2 | +1.9 | +2 | +1.8 | ±10.4A |
| 3 | +1.2 | 0 | 0 | ±10.4A |
| 50% LOAD-KW | +6.2 | +4.9 | +6 | — |
| FREQUENCY | 0 | 0 | -1 | ±3 Hz |
| VOLTAGE 1-2 | +0.2 | +0.2 | +0.3 | ±1.56V |
| 2-3 | +0.8 | +0.8 | +0.9 | ±1.56V |
| 3-1 | -1.7 | -1.3 | -0.8 | ±1.56V |
| CURRENT 1 | -0.9 | -1 | -1.1 | ±10.4A |
| 2 | +2.6 | +3 | +3 | ±10.4A |
| 3 | -0.2 | -0.5 | -0.1 | ±10.4A |

# ADDENDUM D



8000 Ft. 95°F

| | INSTRUMENT ERROR @386 Hz | @400 Hz | @412 Hz | LIMIT |
|---|---|---|---|---|
| 75% LOAD-KW | +7.4 | +7.2 | +6.9 | — |
| FREQUENCY | 0 | 0 | 0 | ±3 Hz |
| VOLTAGE 1-2 | -0.5 | +0.1 | -0.3 | ±1.56V |
| 2-3 | +0.9 | +1.1 | +1.2 | ±1.56V |
| 3-1 | -2.5 | -2.3 | -2.8 | ±1.56V |
| CURRENT 1 | -2.2 | -3.3 | -2.5 | ±10.4A |
| 2 | +3.8 | -4.1 | +3.8 | ±10.4A |
| 3 | -0.8 | -0.4 | -1.4 | ±10.4A |
| 100% LOAD-KW | | +6 | +6.4 | — |
| FREQUENCY | | 0 | 0 | ±3 Hz |
| VOLTAGE 1-2 | | -0.3 | -0.2 | ±1.56V |
| 2-3 | | +2.5 | +2.6 | ±1.56V |
| 3-1 | | -2.1 | -3.2 | ±1.56V |
| CURRENT 1 | | -3.4 | -2.8 | ±10.4A |
| 2 | | +5.6 | +5.4 | ±10.4A |
| 3 | | -2.0 | -1.0 | ±10.4A |

(511.1) REGULATOR RANGE TEST AT 8000 FT, 95°F
RDGS 390 - 403
LIMIT - 1% (PD. 3.5.5)

208V TI RESULTS = $\frac{123.8 - 121.5}{1.215}$ = 1.89%

MASTER DATA = $\frac{122.2 - 122.0}{1.22}$ = 0.16%

219V TI RESULTS = $\frac{129.7 - 127.4}{1.274}$ = 1.81%

MASTER DATA = $\frac{127.6 - 127.2}{1.272}$ = 0.31%

242V TI RESULTS = $\frac{143.5 - 141.3}{1.413}$ = 1.56%

MASTER DATA = $\frac{141.0 - 140.7}{1.407}$ = 0.21%

197V TI RESULTS = $\frac{117.3 - 114.8}{1.148}$ = 2.18%

MASTER DATA = $\frac{115.7 - 115.3}{1.153}$ = 0.35%

MIN VOLTAGE TI OBSERVED (C-N.) = 107.5V
MASTER " (C-N) = 106.7V.

# ADDENDUM D
## 8000 FT ALT, 95°F



17 608.1 FREQUENCY AND VOLTAGE REGULATION STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| LIMITS | BAND WIDTH @ LOAD | .5% | 1% |
| | NO LOAD | .5% | 1% |
| | REGULATION | .5% | 1% |
| | UNLOAD OVERSHOOT | 1.5% | 15% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| | LOAD UNDERSHOOT | 1.5% | 15% |
| | RECOVERY TIME | 1 SEC | .35 SEC |
| FULL LOAD RDGS (130KW) | | | |
| | BAND WIDTH @ LOAD | *NEG | NEG |
| | NO LOAD | .05% | NEG |
| | REGULATION | .125% | 3.58% |
| | UNLOAD OVERSHOOT | 11.0% | 3.58% |
| | RECOVERY TIME | 11.16 SEC | .275EC |
| | LOAD UNDERSHOOT | .625% | 1.92% |
| | RECOVERY TIME | .90 SEC | .24 SEC |
| 3/4 LOAD (97.5KW) | READINGS | | |
| | BAND WIDTH @ LOAD | NEG. | NEG |
| | NO LOAD | .088% | NEG |
| | REGULATION | .05% | 1.83% |
| | UNLOAD OVERSHOOT | 6.38% | .75% |
| | RECOVERY TIME | 7.50 SEC | .09 SEC |
| | LOAD UNDERSHOOT | .250% | 1.00% |
| | RECOVERY TIME | .15 SEC | NEG |
| 1/2 LOAD (75KW) | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | NEG |
| | NO LOAD | NEG. | NEG |
| | REGULATION | NEG | .79% |
| | UNLOAD OVERSHOOT | .93% | NEG |
| | RECOVERY TIME | 2.67 SEC | NEG |
| | LOAD UNDERSHOOT | NEG | NEG |
| | RECOVERY TIME | NEG | NEG |

* NEGLIGIBLE

# ADDENDUM D



## 8000 FT ALT., 95°F

17 (CONT.) 608.1 FREQUENCY AND VOLTAGE REGULATION, STABILITY (SHORT TERM) AND TRANSIENT RESPONSE (MAX VALUES)

| | | FREQUENCY | VOLTAGE |
|---|---|---|---|
| 1/4 LOAD (112 KW) | READINGS | | |
| | BAND WIDTH @ LOAD | NEG. | NEG |
| | NO LOAD | | NEG |
| | REGULATION | | .5% |
| | UNLOAD OVERSHOOT | | NEG |
| | RECOVERY TIME | | |
| | LOAD UNDERSHOOT | | |
| | RECOVERY TIME | | |
| FULL LOAD (138 KW) | READINGS | | |
| | BAND WIDTH @ LOAD | NEG | .33% |
| | NO LOAD | .07% | NEG. |
| | REGULATION | .112% | (1.83%) |
| | UNLOAD OVERSHOOT | (10.75%) | 3.00% |
| | RECOVERY TIME | (10.50SEC) | .24SEC |
| | LOAD UNDERSHOOT | .625% | 1.83% |
| | RECOVERY TIME | .84SEC | .30SEC |

FORM 3152A

AD5210-00006

Detroit Diesel Allison
Division of General Motors Corporation

TITLE ENG T3 ACCEPT TEST 100% LOCK-UP CURVE NO. _____

PREPARED BY _____ DATE _____ TEST DATE _____

DEPARTMENT _____

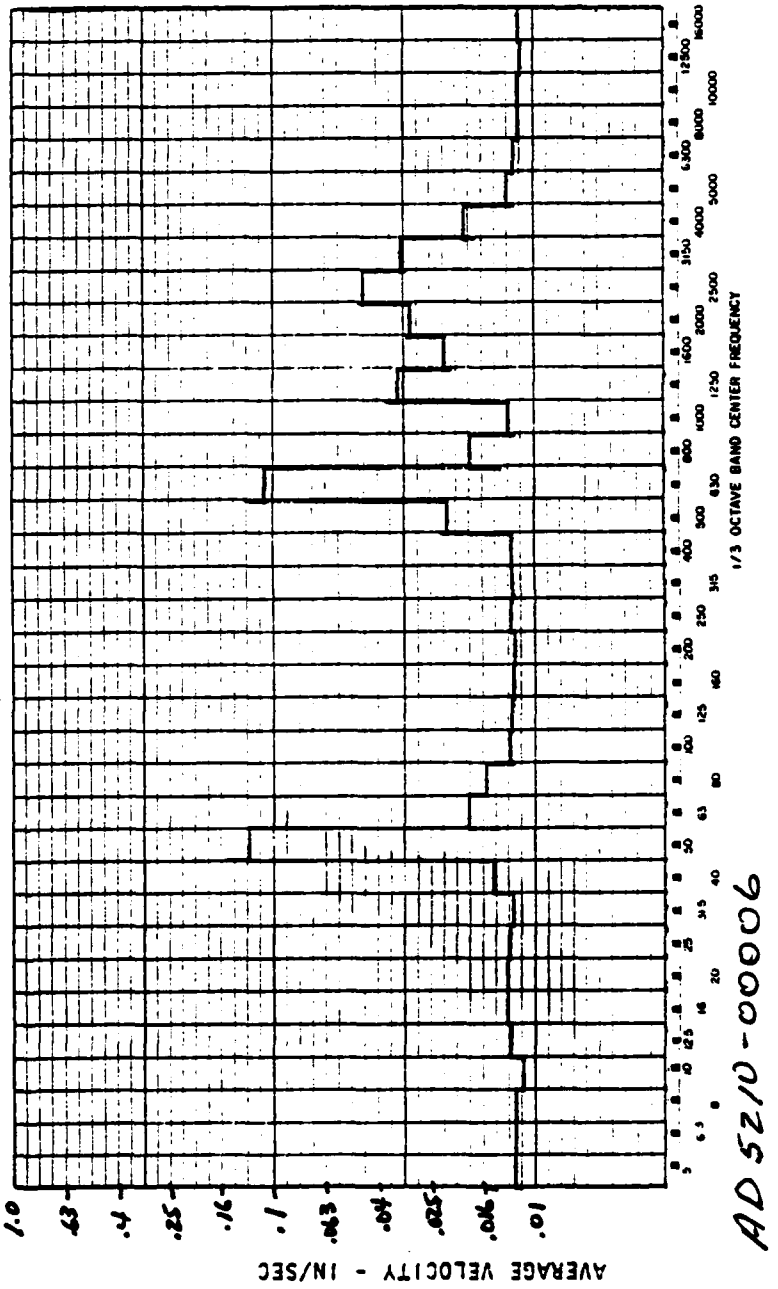
VIBRATION SIGNATURE

ENG. S/N T3 BU 8 TEST STAND 887

DATE 9-17-79 TIME _____

VIBRATION METER READING .14 PICKUP LOCATION FWD VERTICAL

$N_1$ 36830 RPM $N_2$ 3000 RPM




AD 5210-00006

FORM 3152A

AD5210-00007

Detroit Diesel Allison
Division of General Motors Corporation

TITLE ENG T3 ACCEPT TEST 100% LOCK-UP CURVE NO.

PREPARED BY DATE TEST DATE

DEPARTMENT

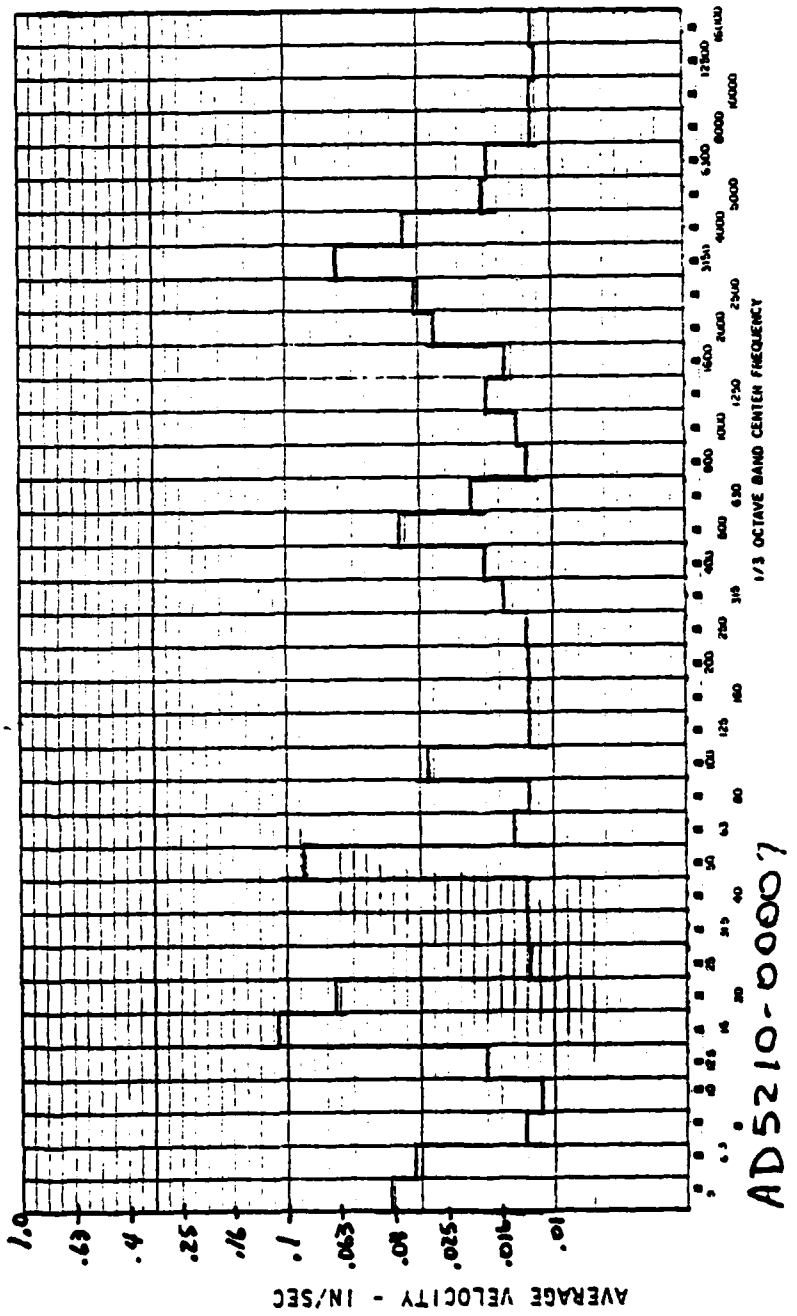
VIBRATION SIGNATURE

ENG. S/N T3 BU 8 TEST STAND 8P7

DATE 9/17/79 TIME

VIBRATION METER READING .11-.12 PICKUP LOCATION FRT LATERAL

$N_1$ 36830 RPM $N_2$ 3000 RPM




AD5210-00007

FORM 3152A

AD5210-00008

**Detroit Diesel Allison**
Division of General Motors Corporation

TITLE ENG T3 ACCEPT TEST — CURVE NO
100% LOCK-UP
PREPARED BY — DATE — TEST DATE
DEPARTMENT

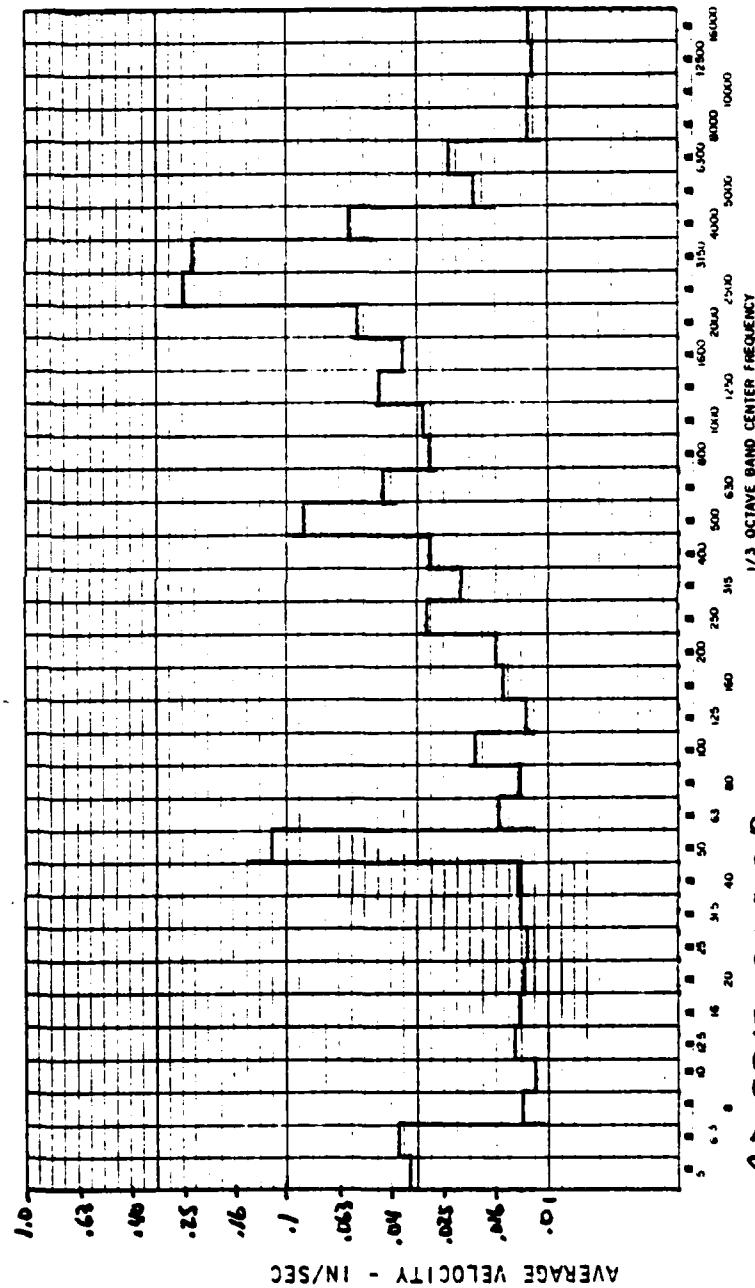
VIBRATION SIGNATURE

ENG. S/N T3 BU 8 TEST STAND 887

DATE 9/17/79 TIME 2340

VIBRATION METER READING .27-.29 PICKUP LOCATION REAR LATERAL

$N_1$ 36830 RPM $N_2$ 3000 RPM

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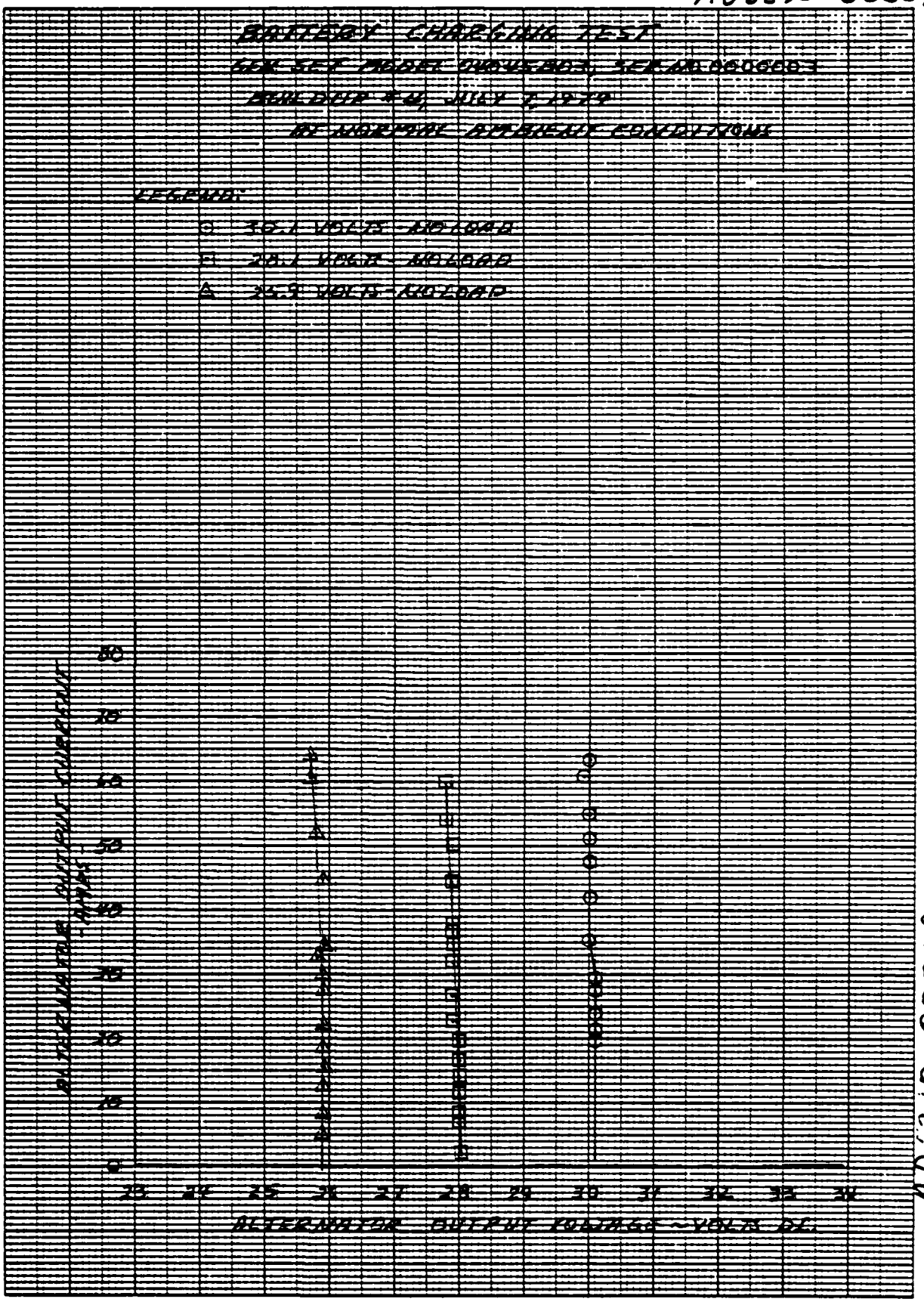
AD5210-00009



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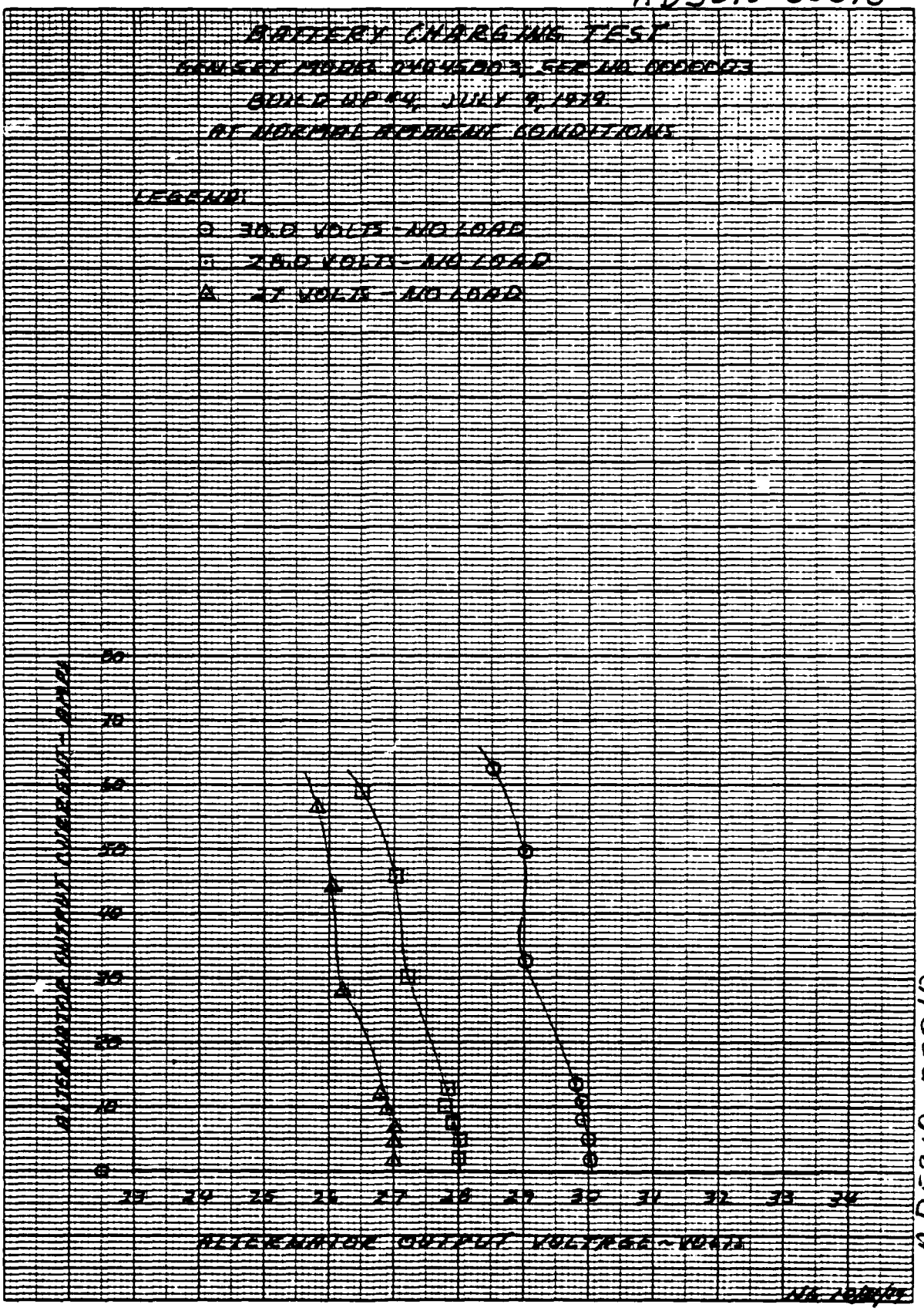
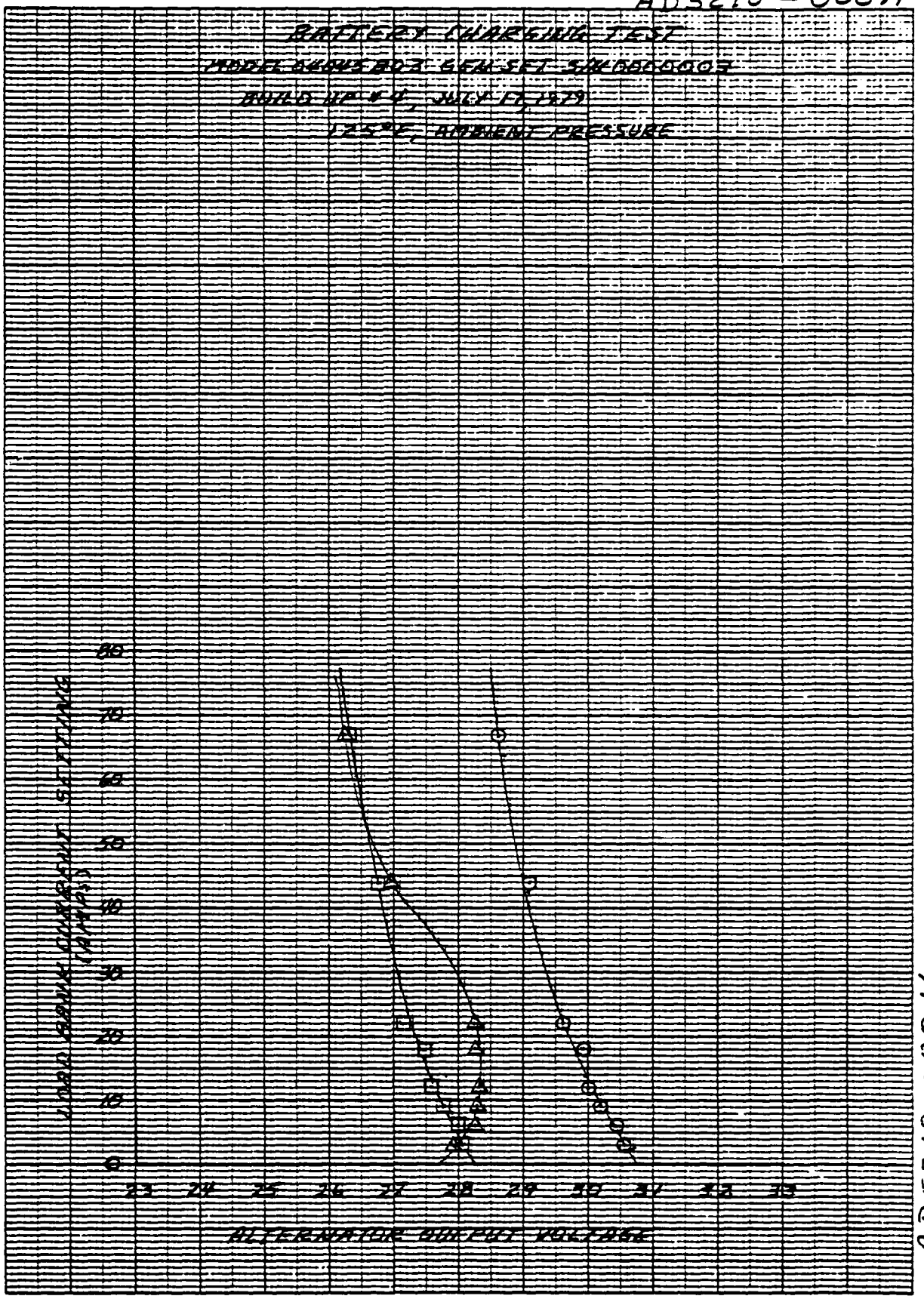
AD5210-00010






AD5210-00010

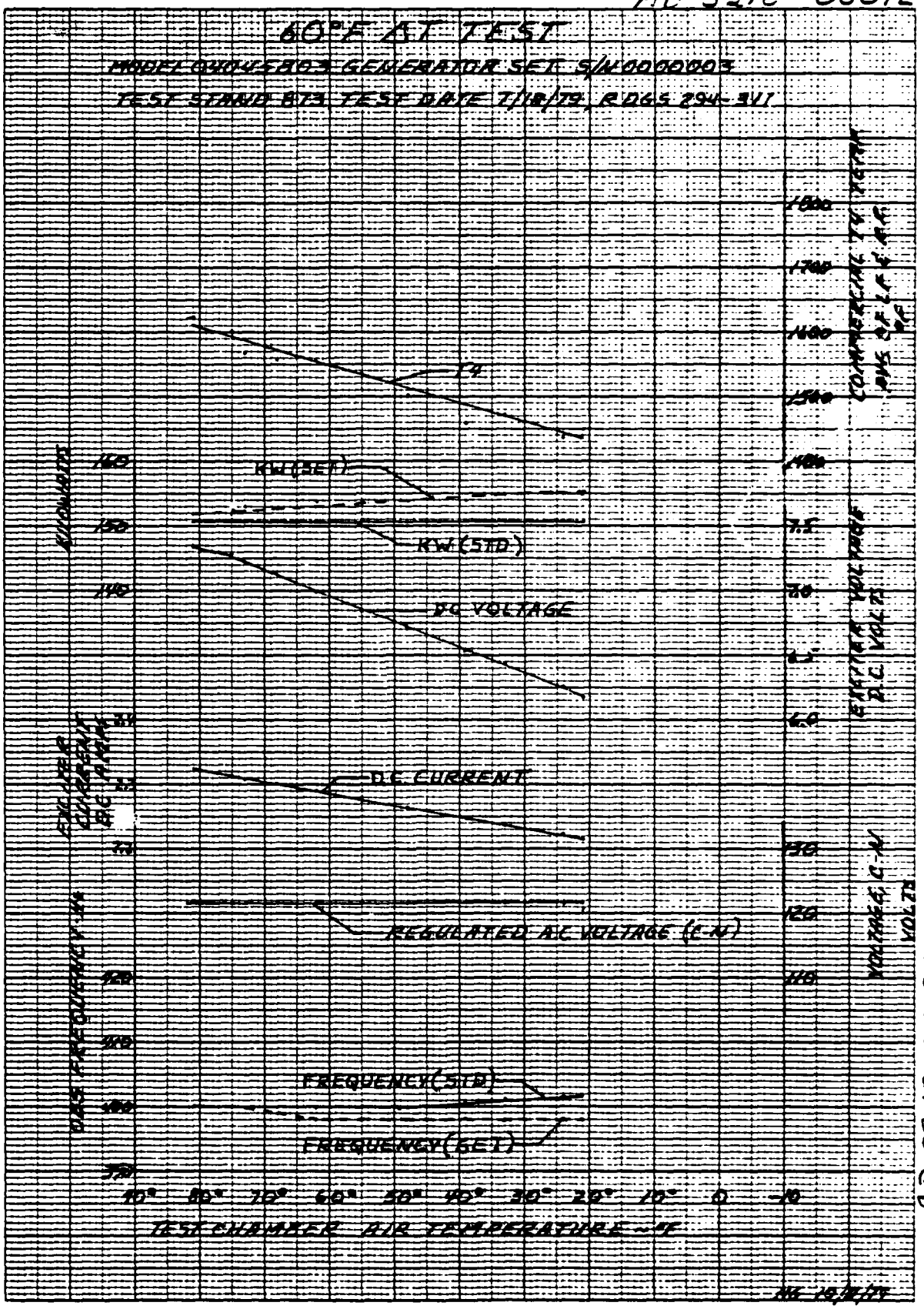
AD5210 - 00011






AD5210-00011

AD 521C-00012

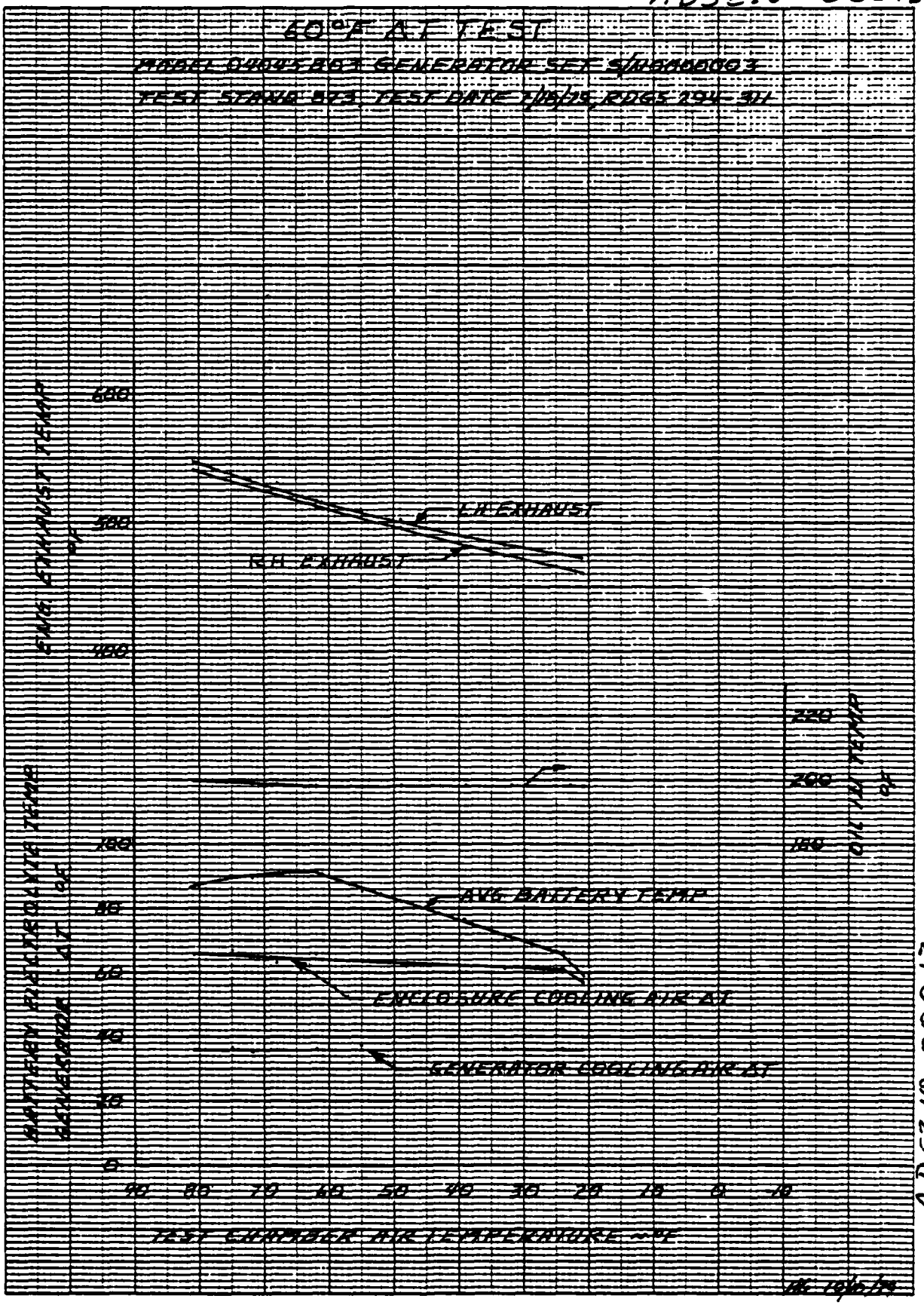


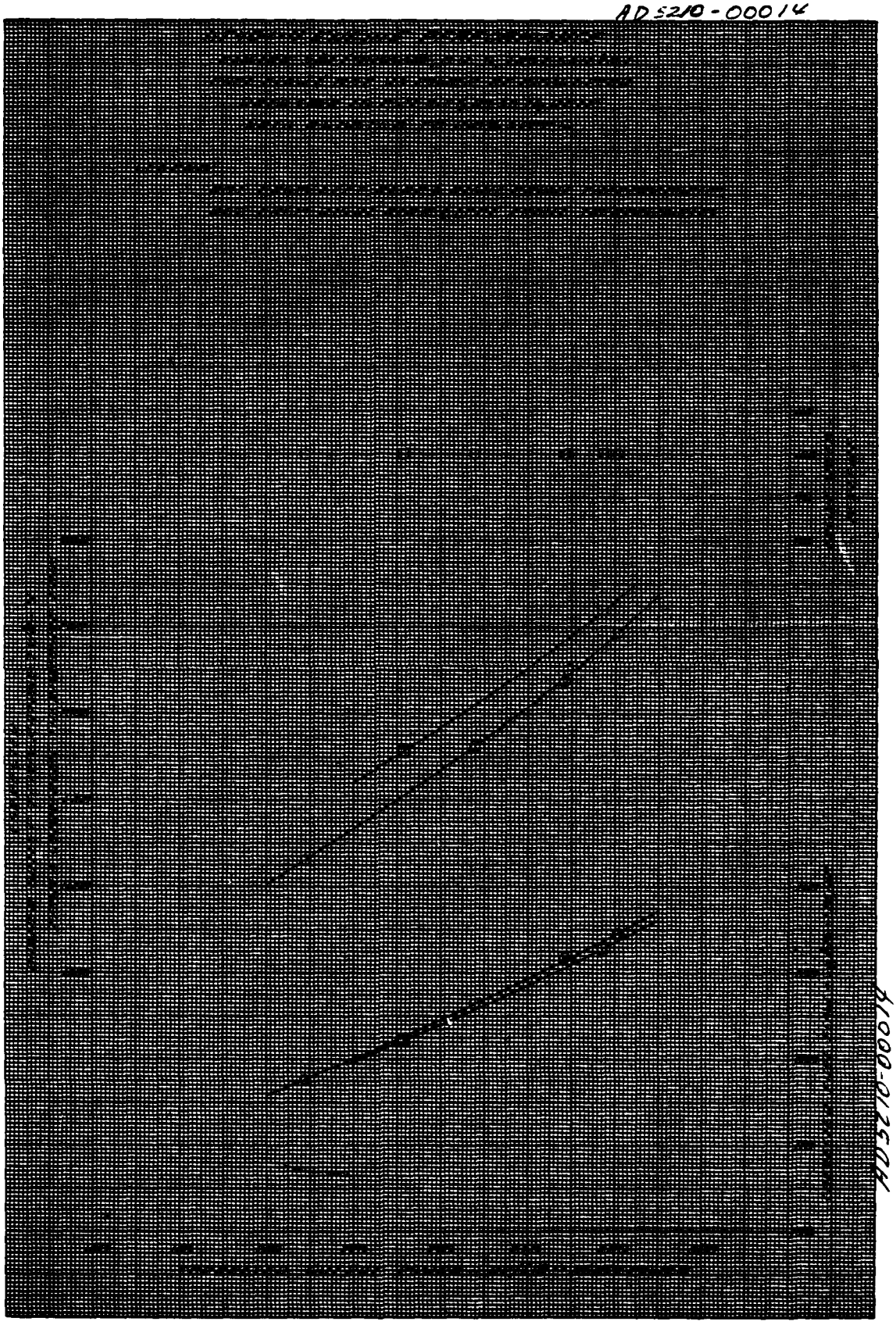

TELLODYNE NATIONAL TRACING PAPER INDIANAPOLIS INDIANA

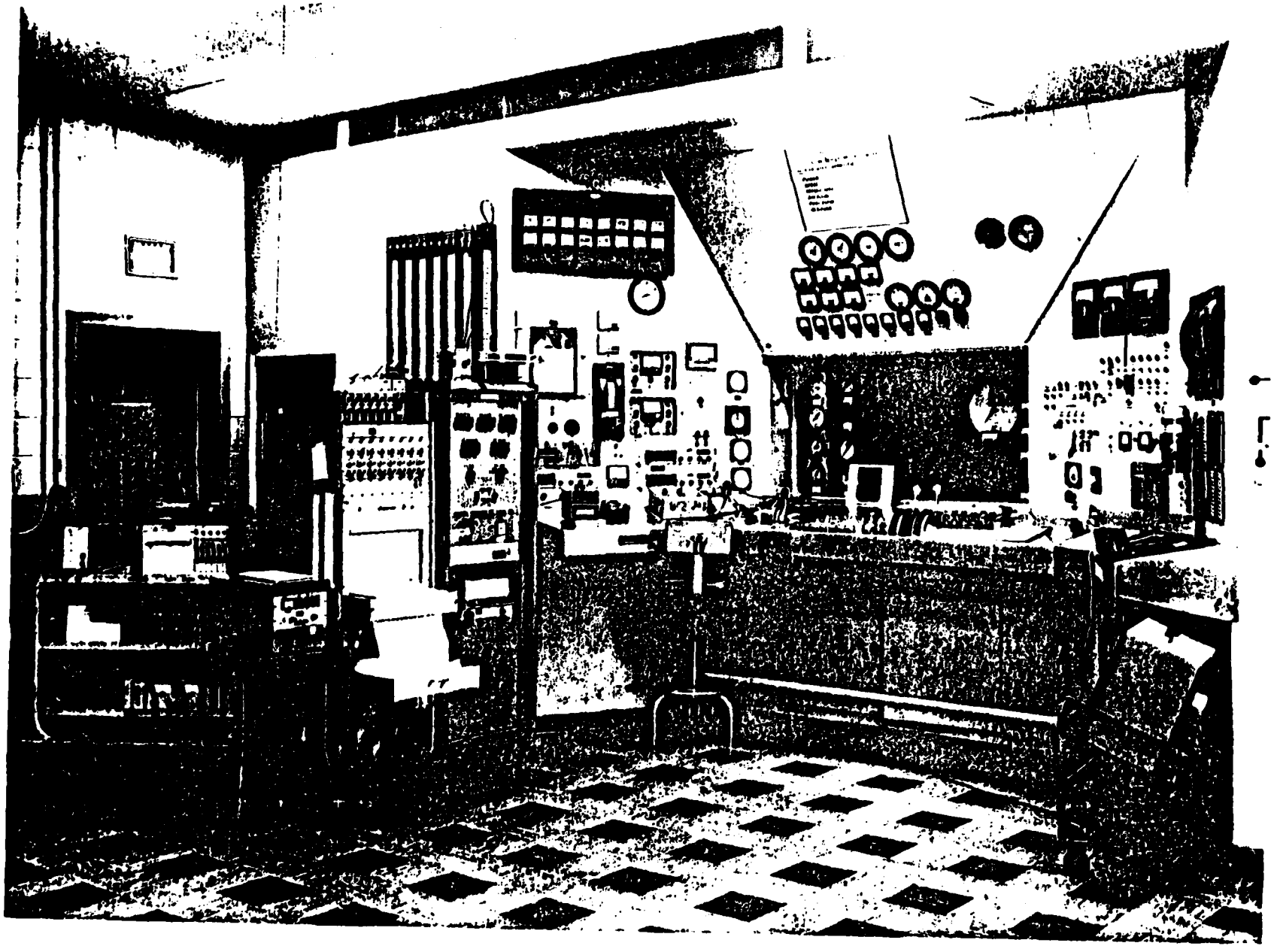
2 AUT THIS 10X10 TO 1 INCH LITHO IN U.S.A.

AD 5210-00012

AD5210-00013

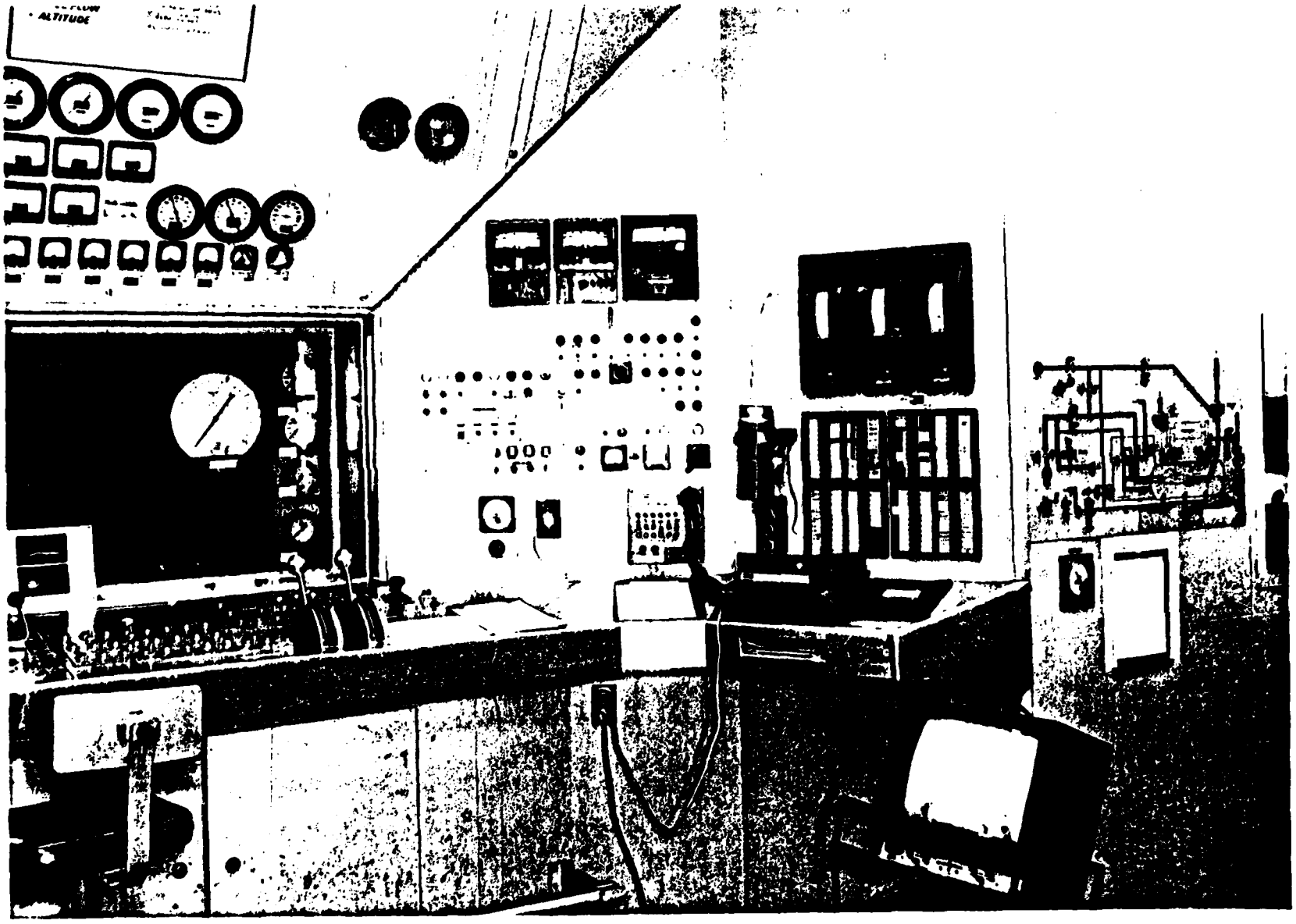






ENVIRONMENTAL TEST GENERATOR SET, S/N 0000003

350363

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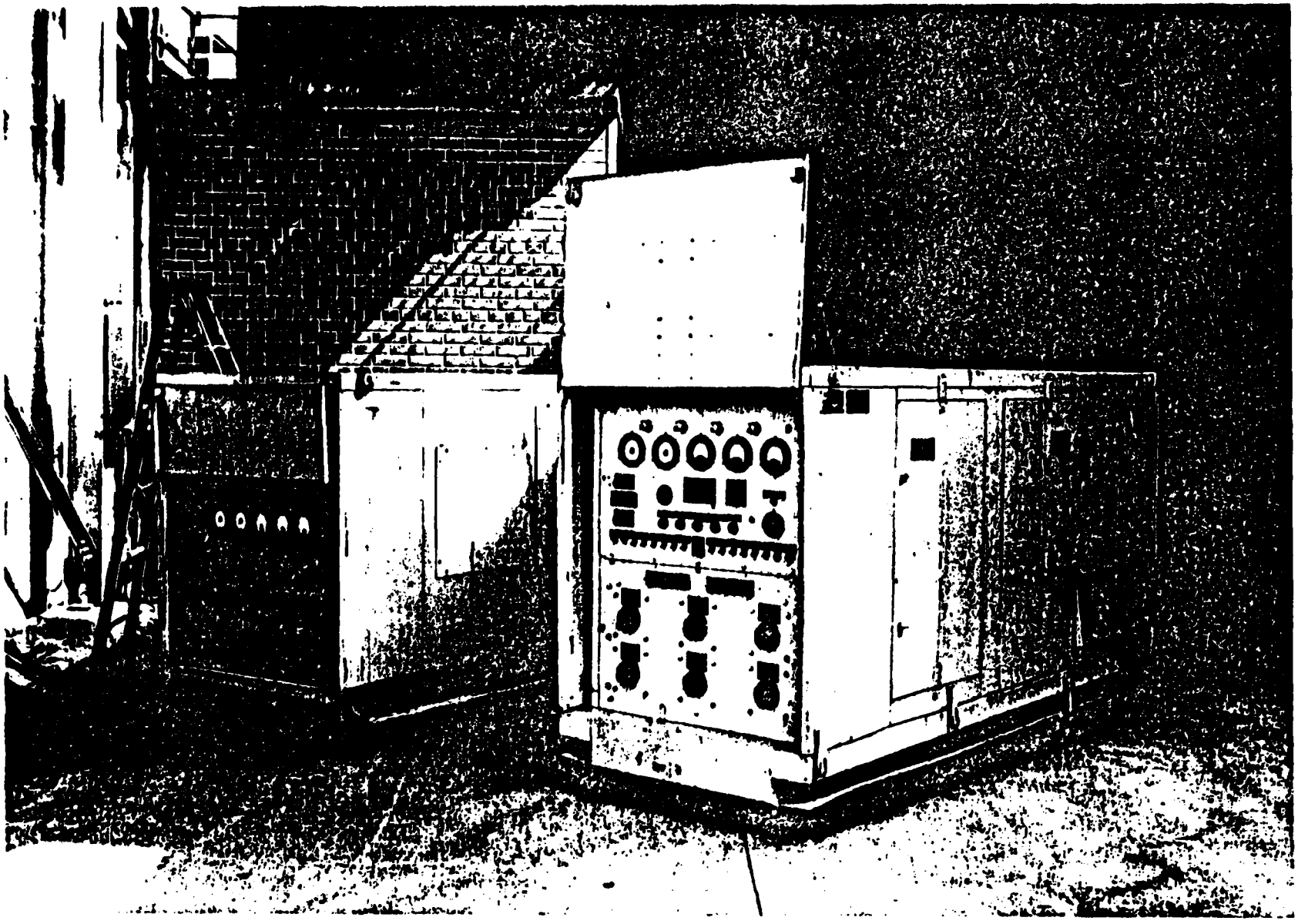

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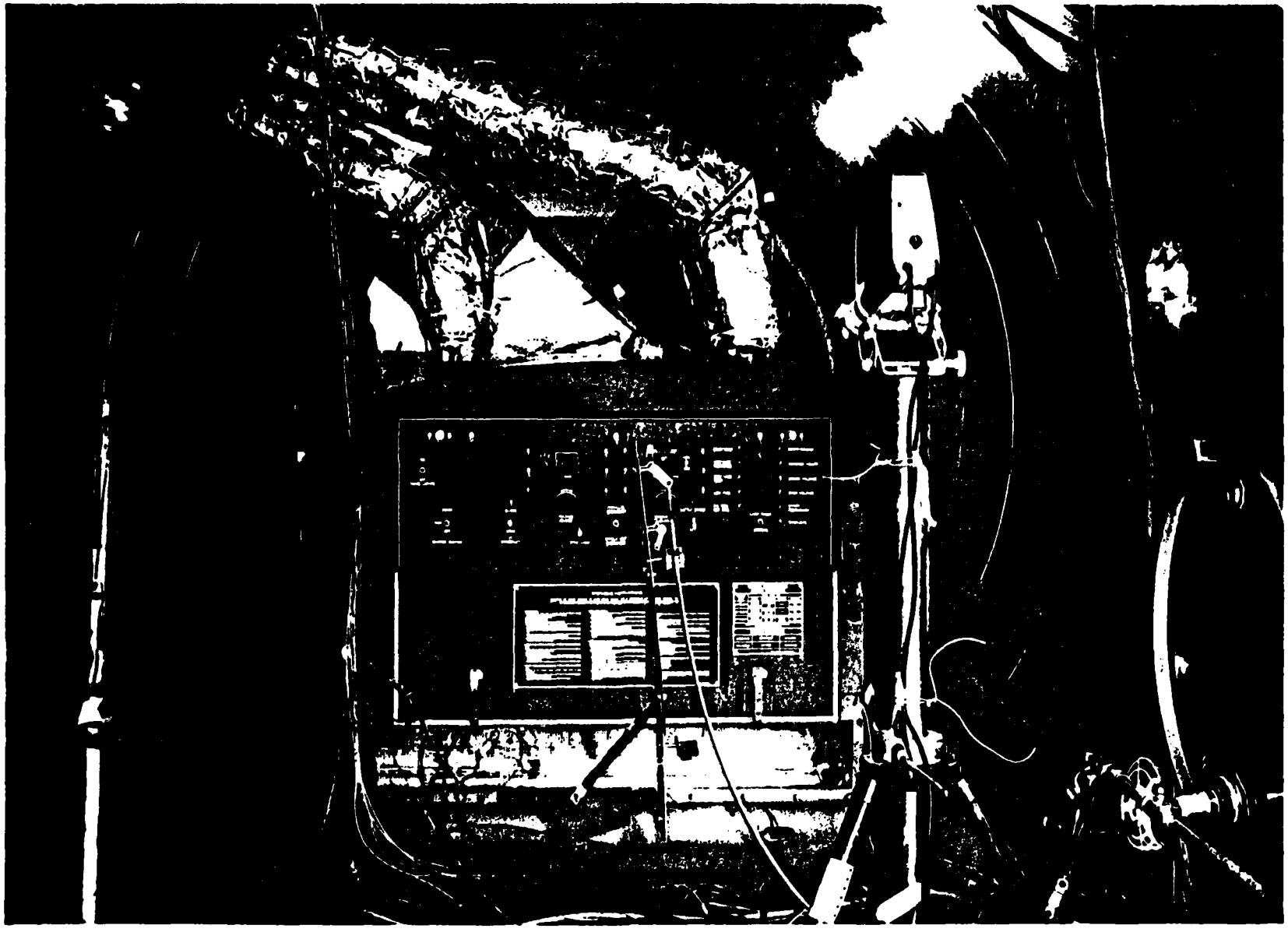
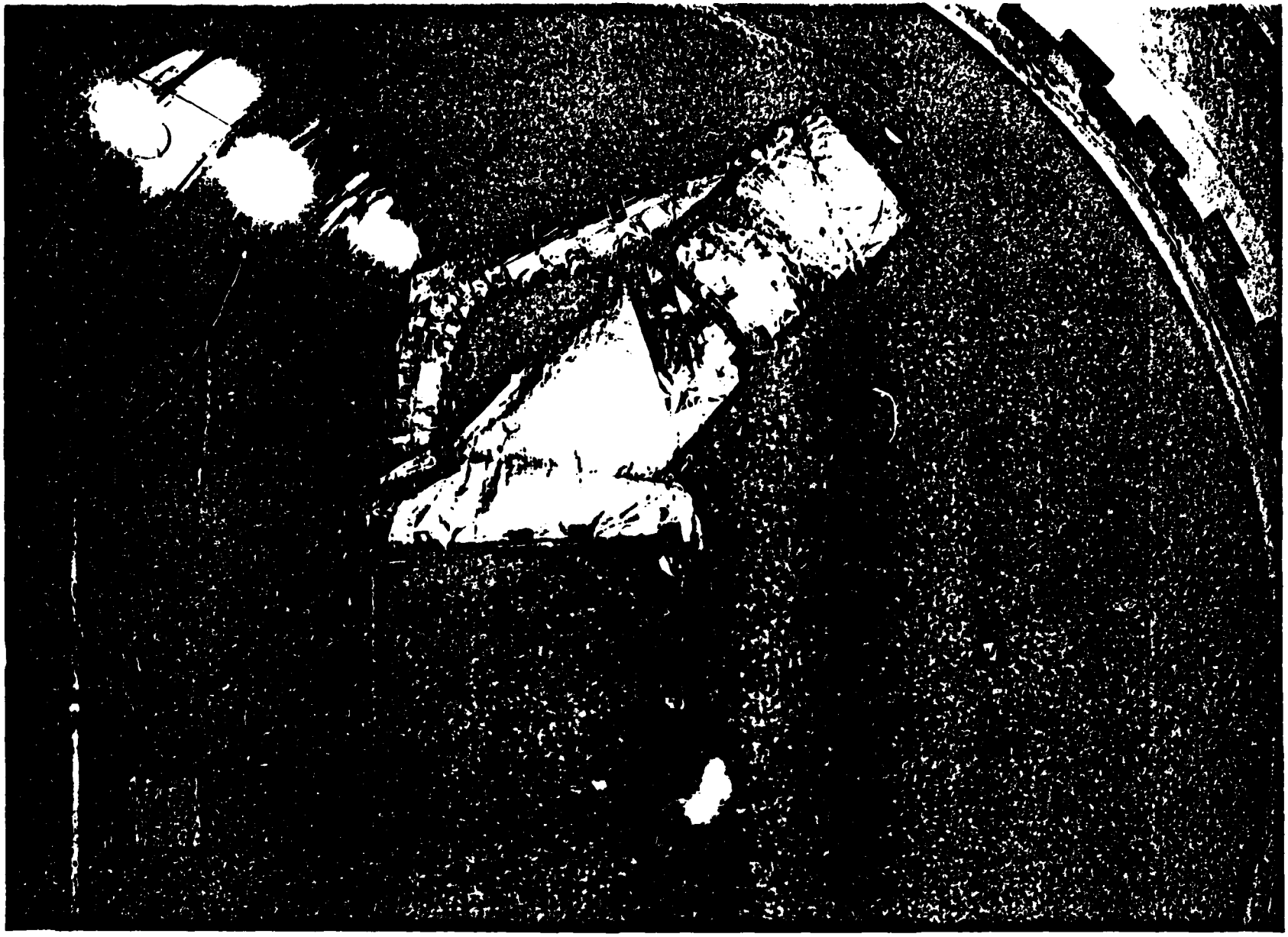


ENVIRONMENTAL TEST GENERATOR SET, S/N 0000003. 350366



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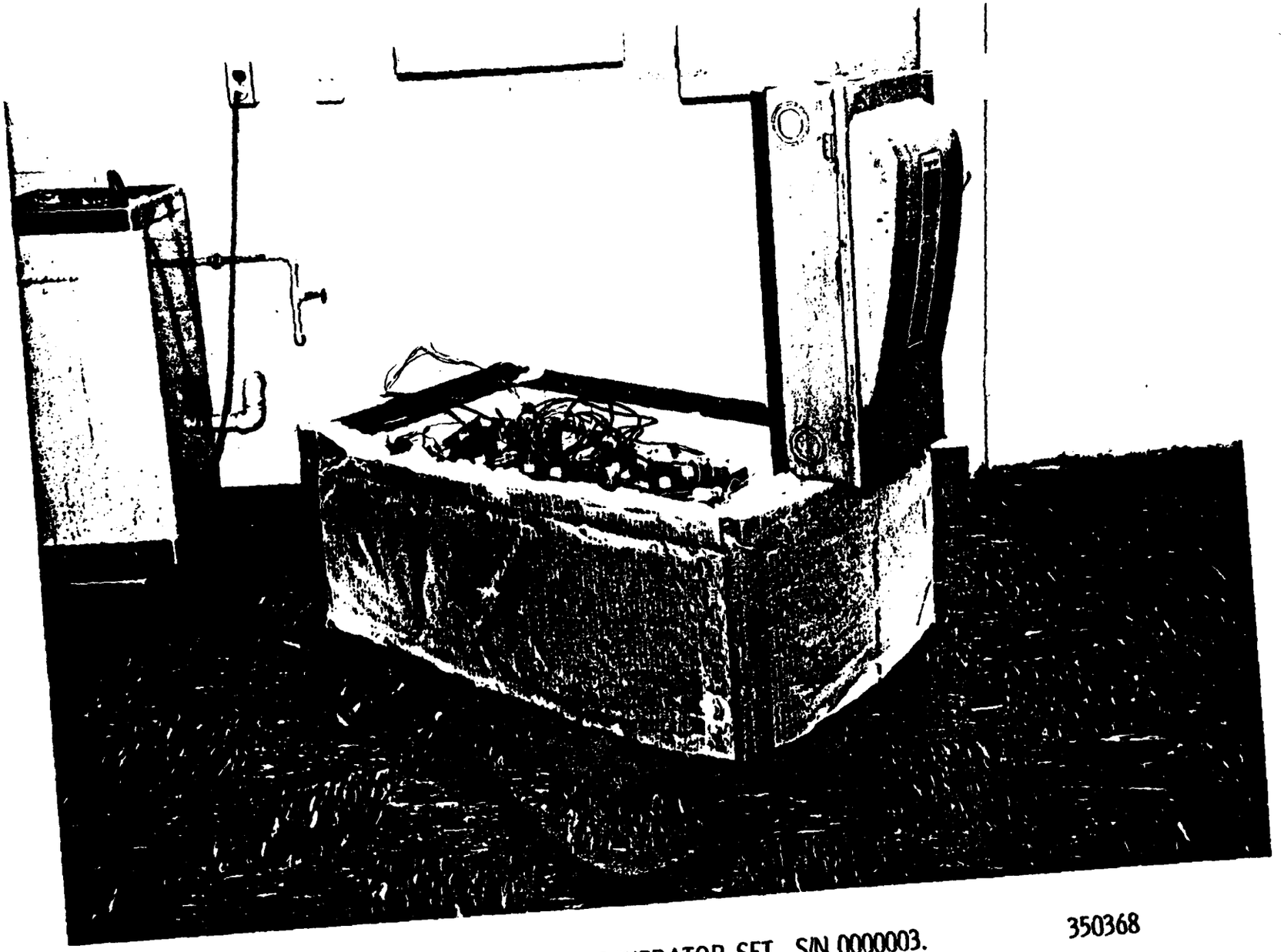
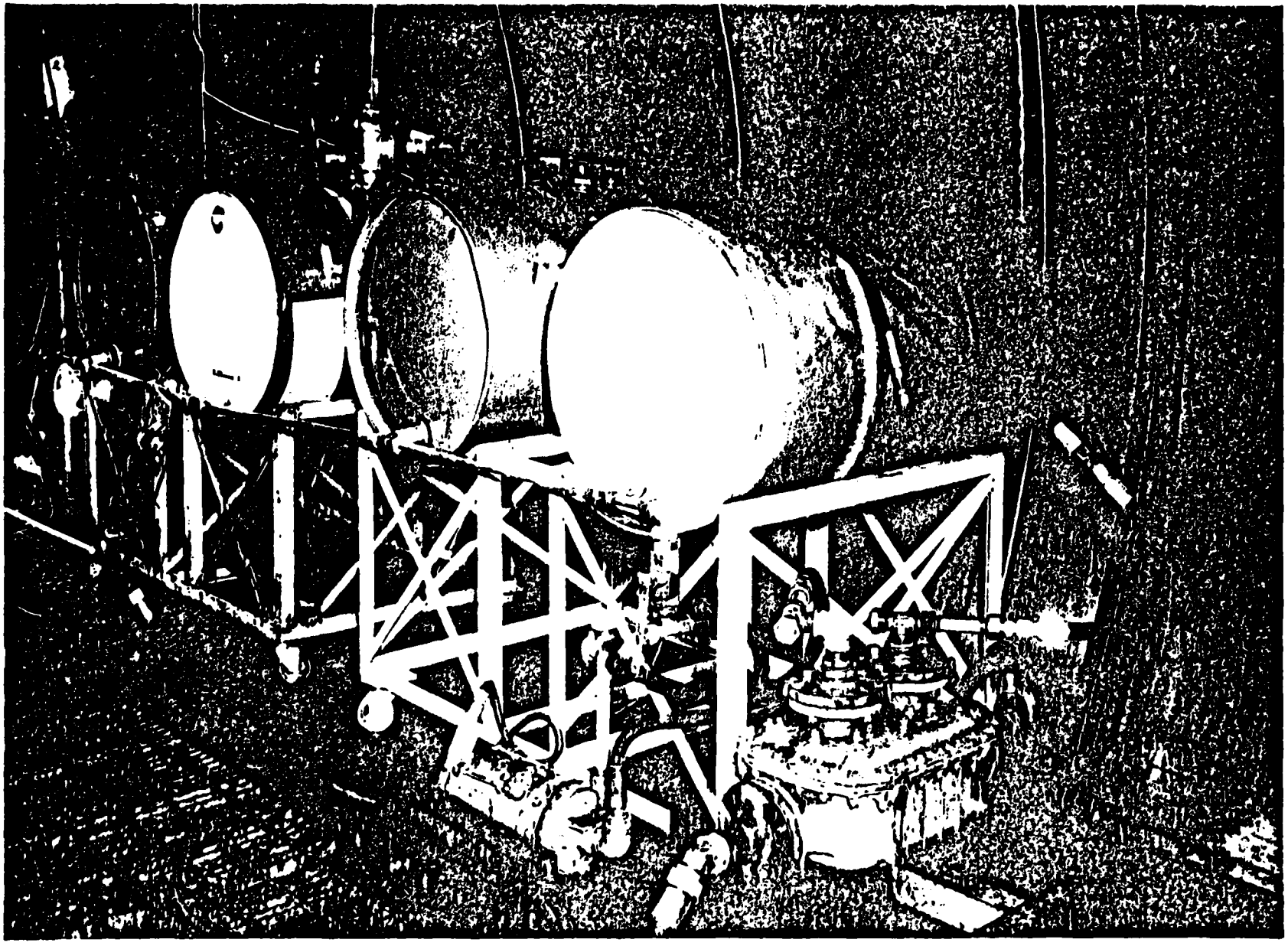


ENVIRONMENTAL TEST GENERATOR SET, S/N 0000003.

350368



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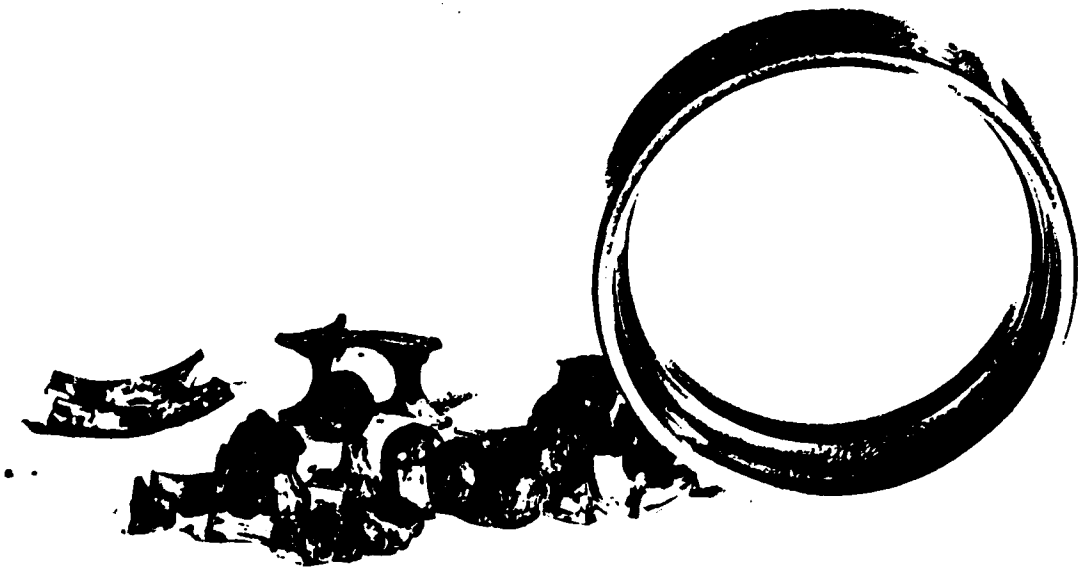
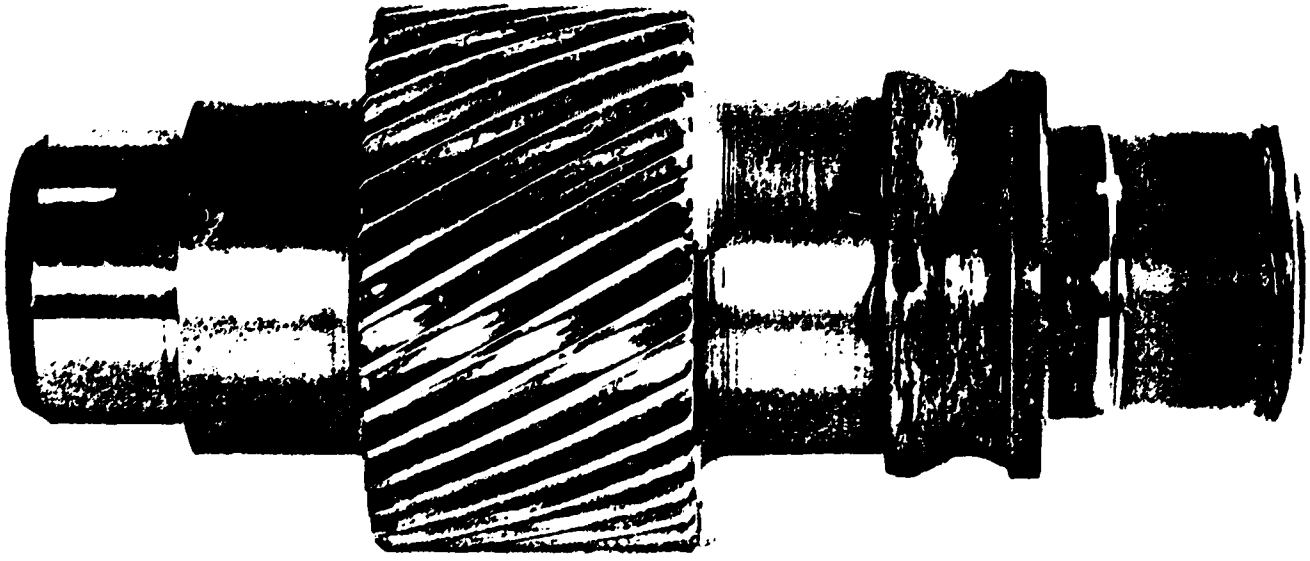
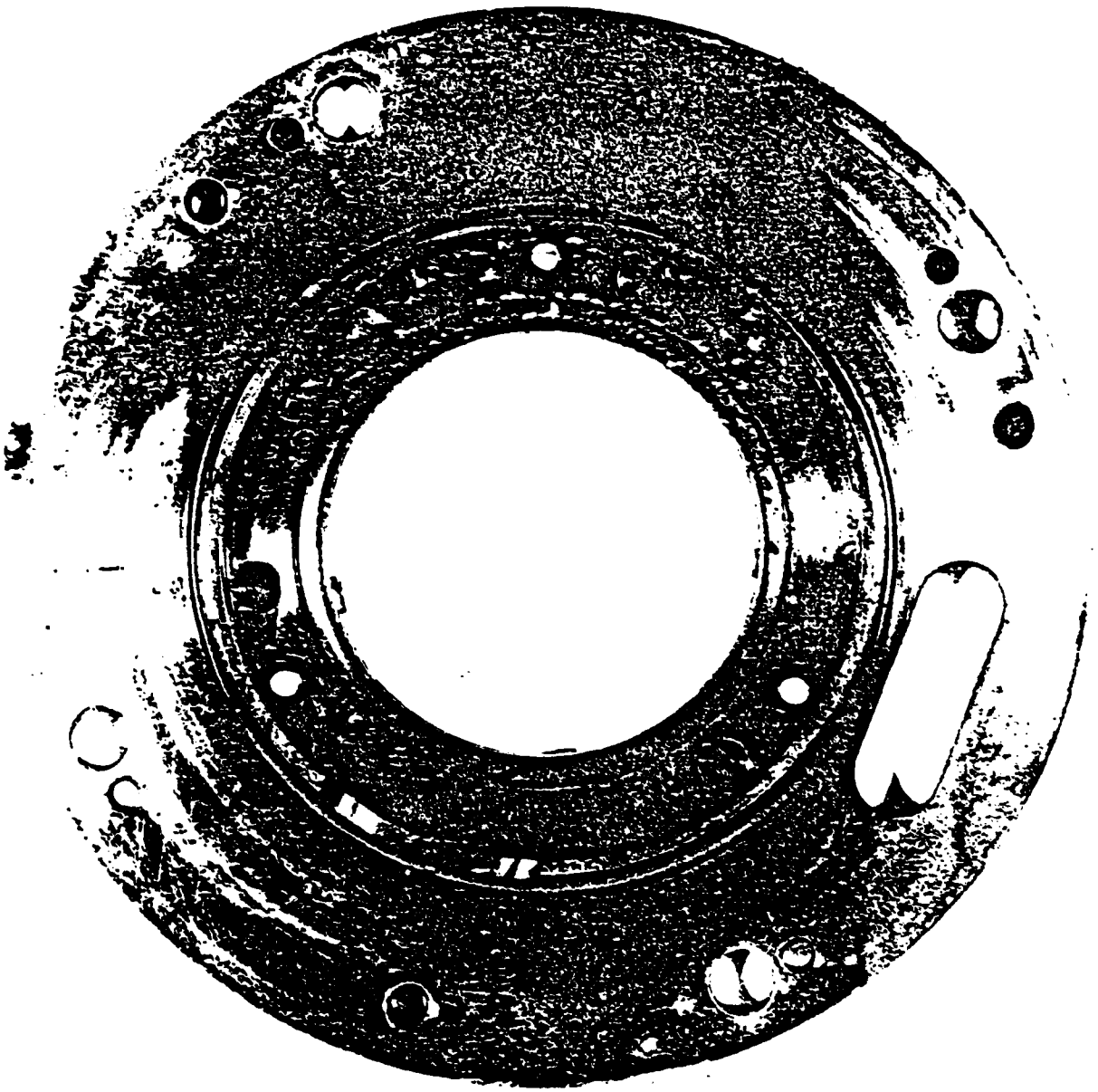
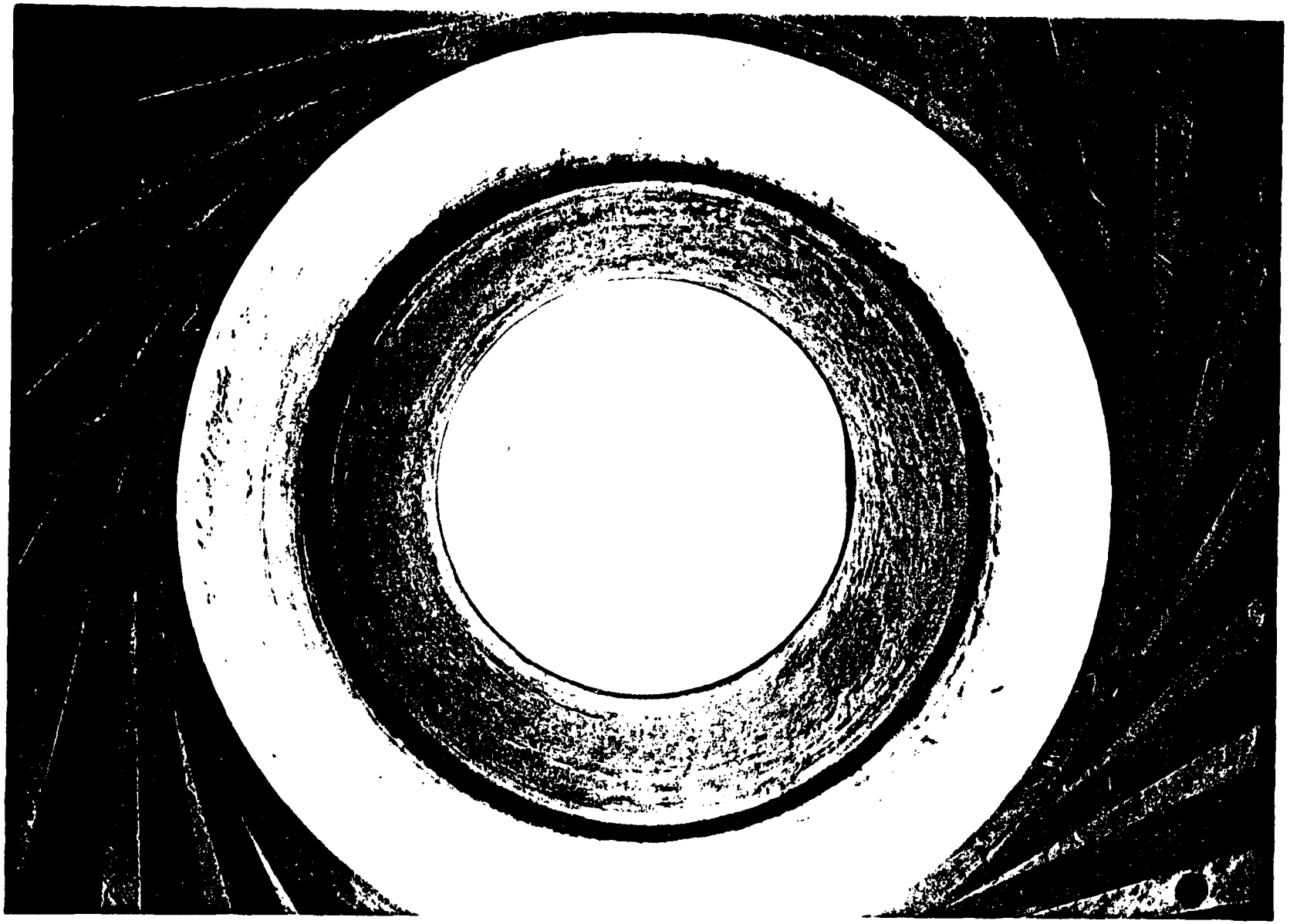






-50°F COLD TEST BRG. FAILURE, GEN. SET #3, ENG. T3, B.U. 7. 351421



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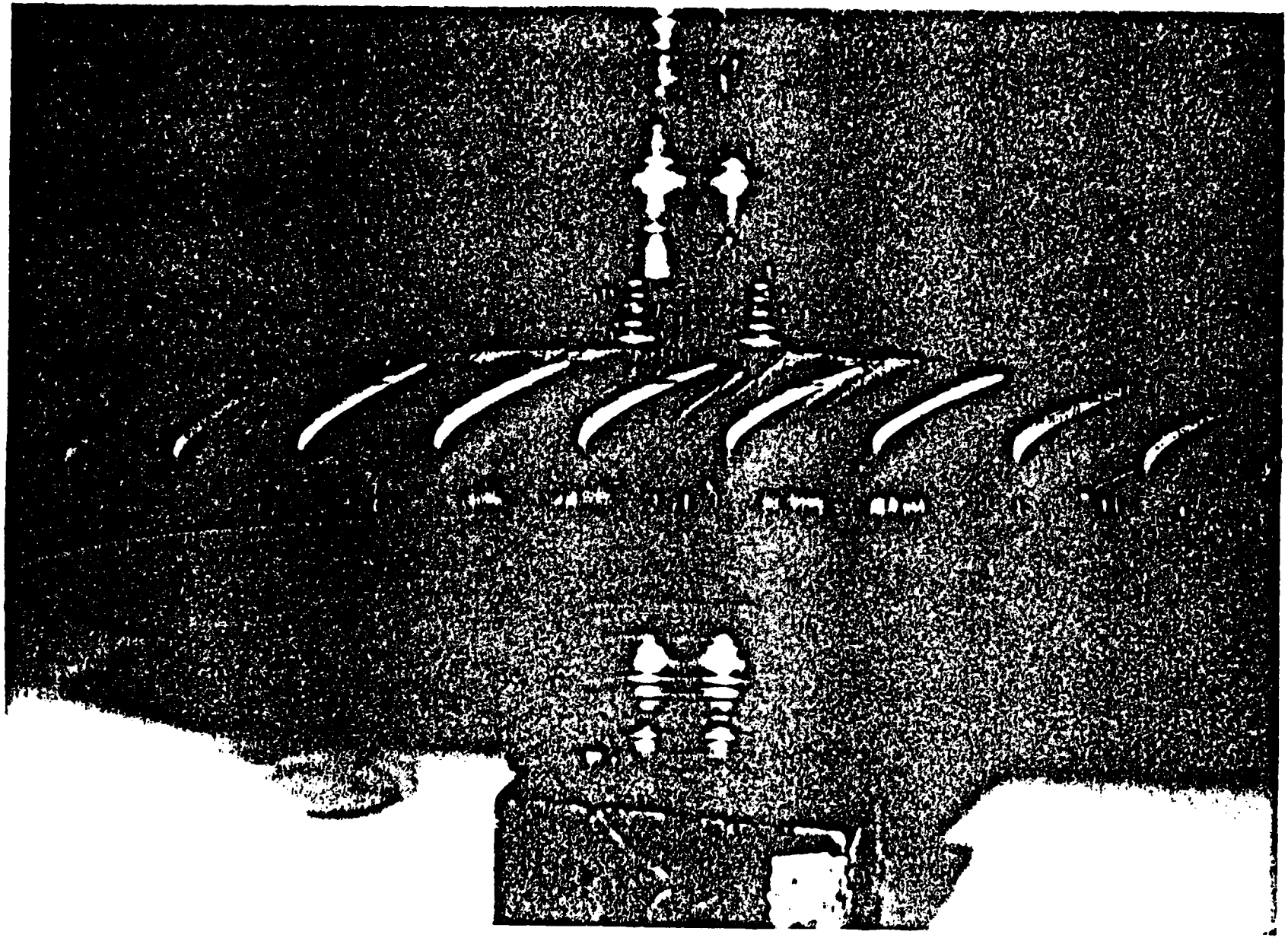

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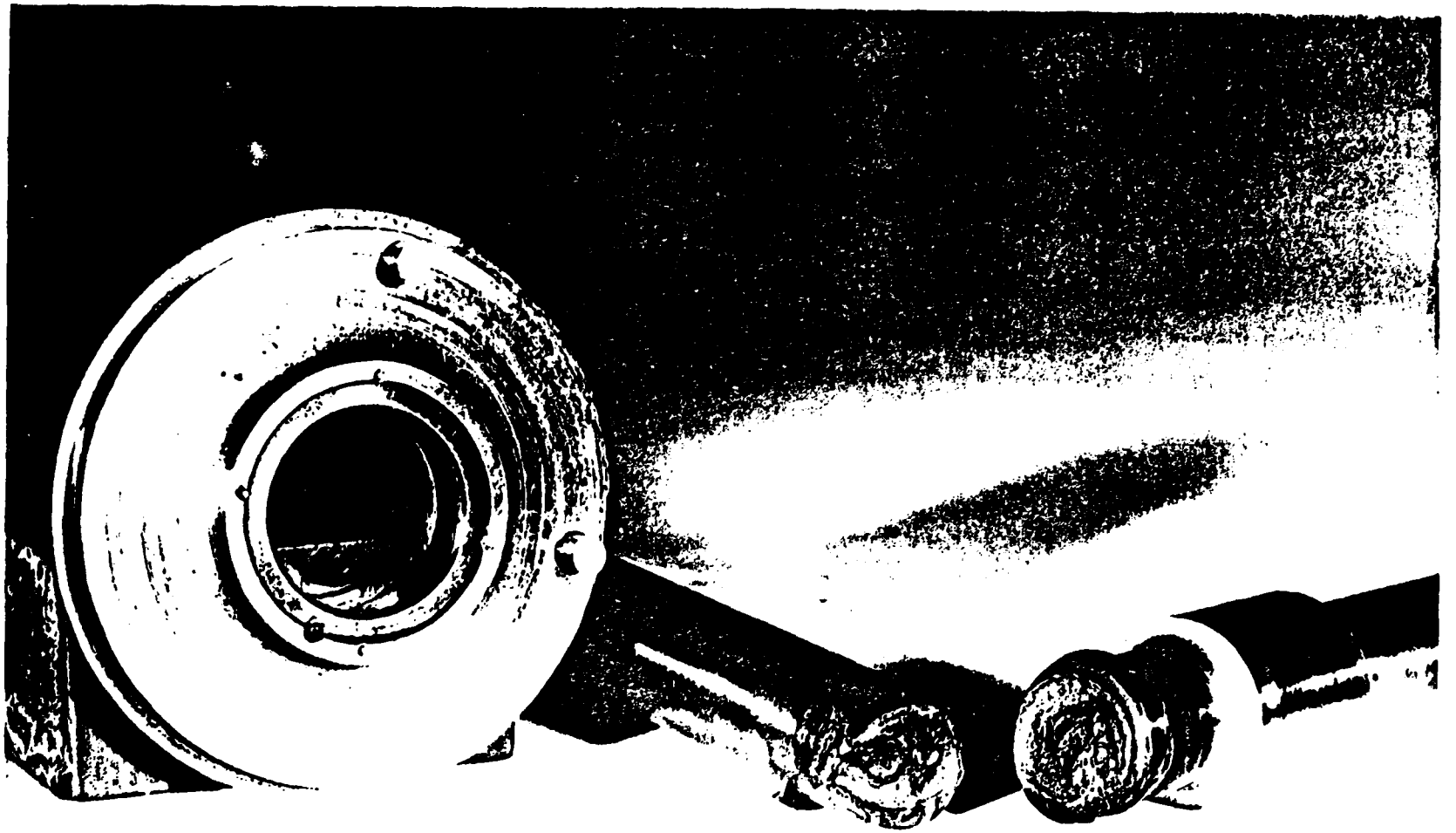

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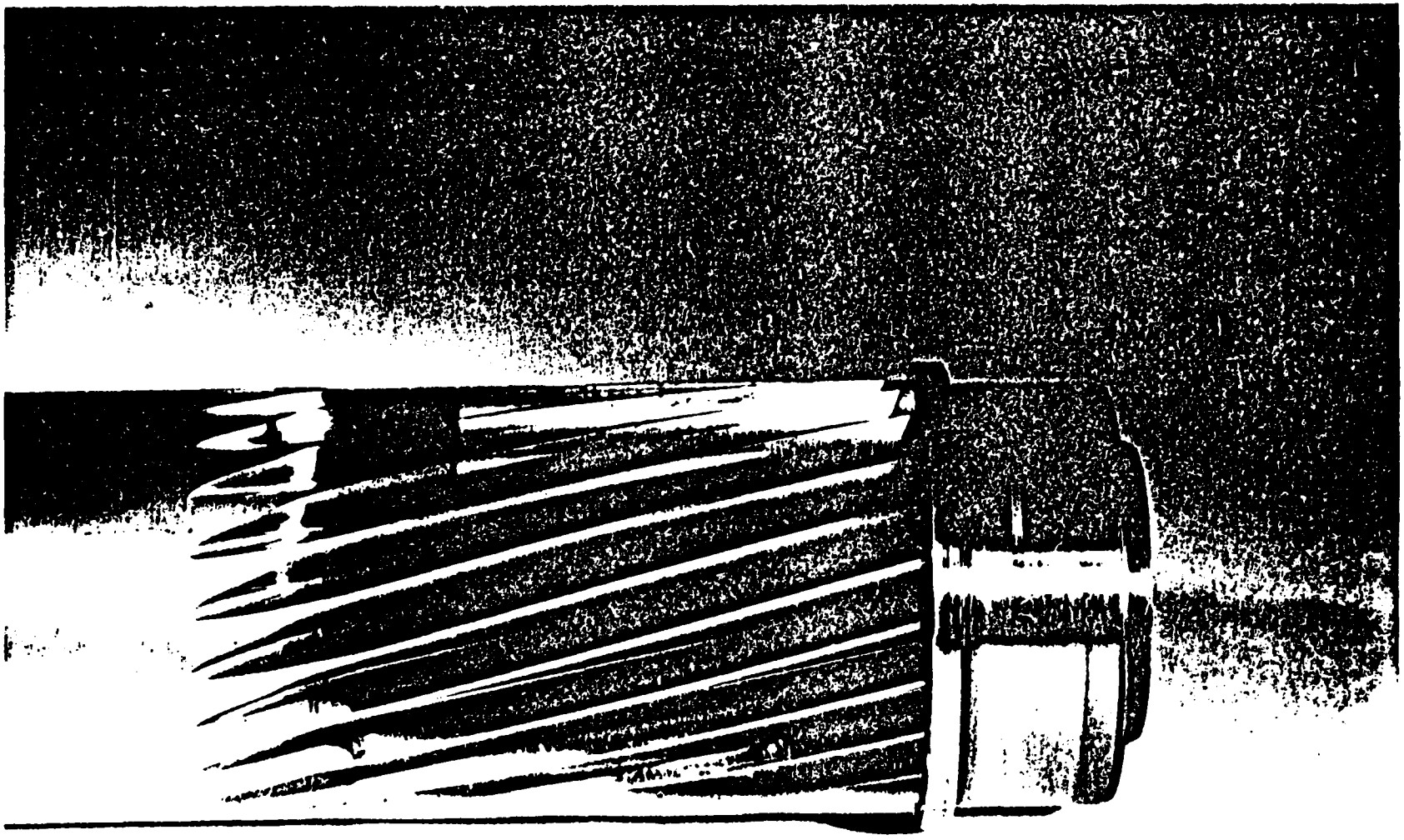

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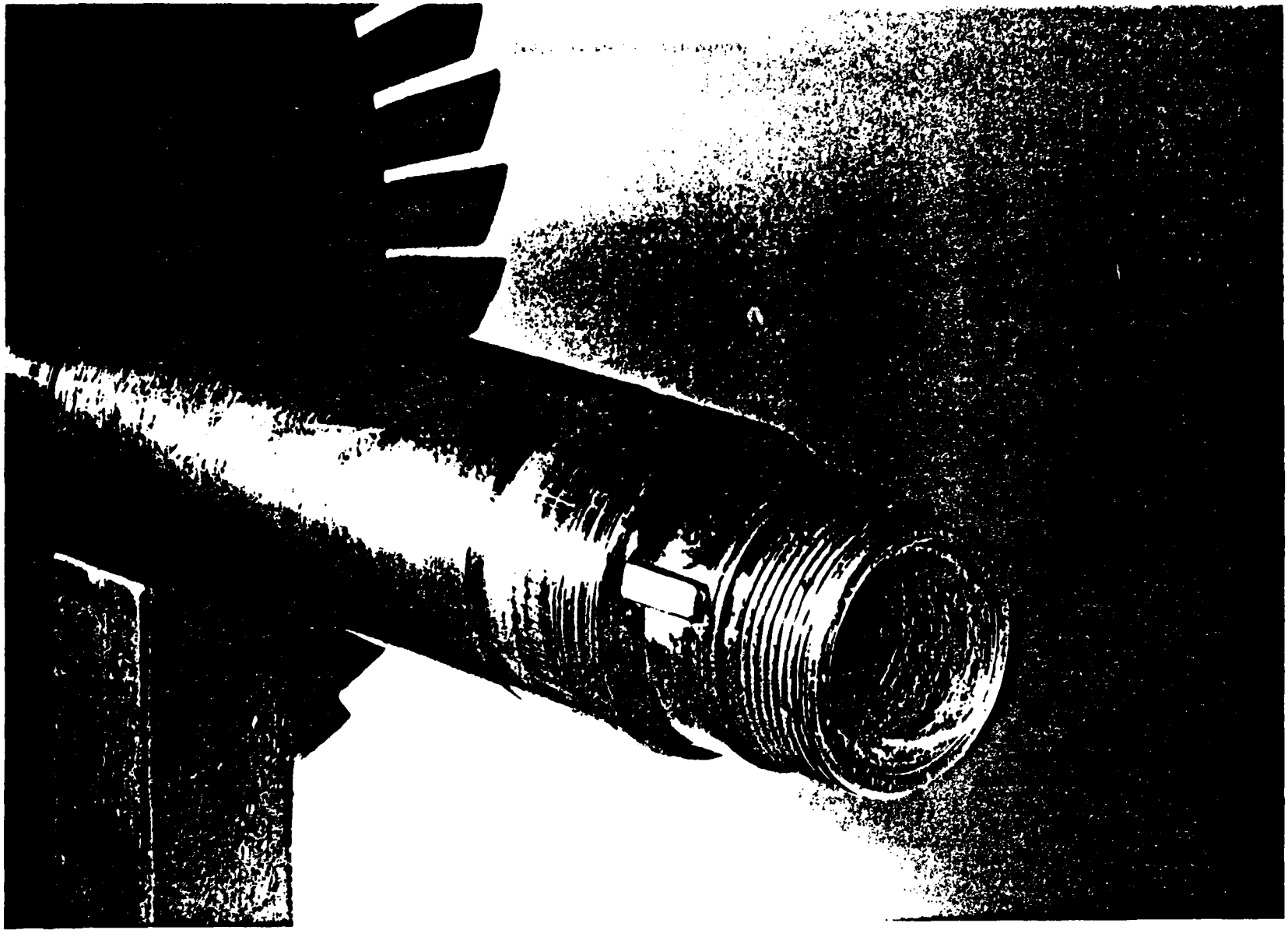

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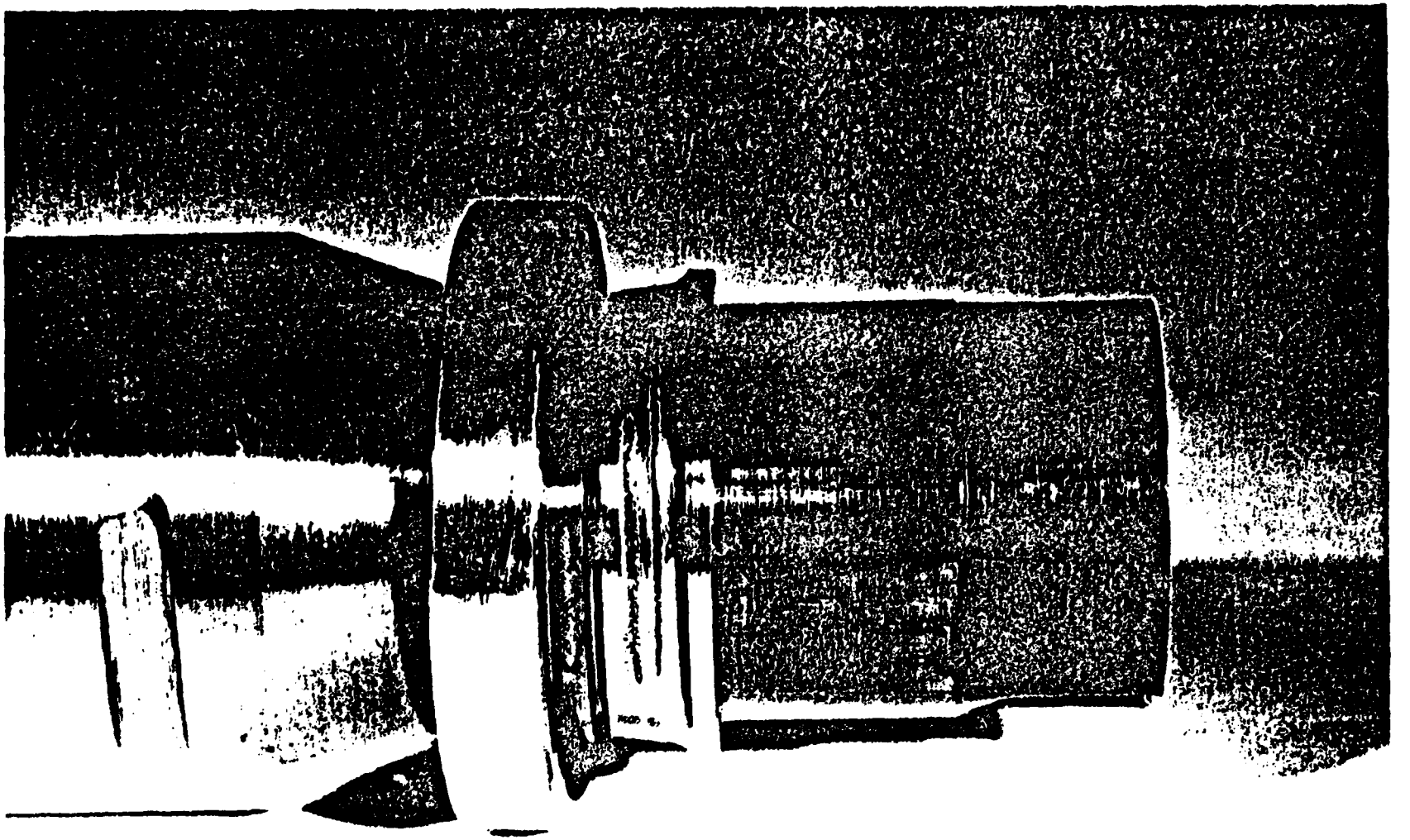

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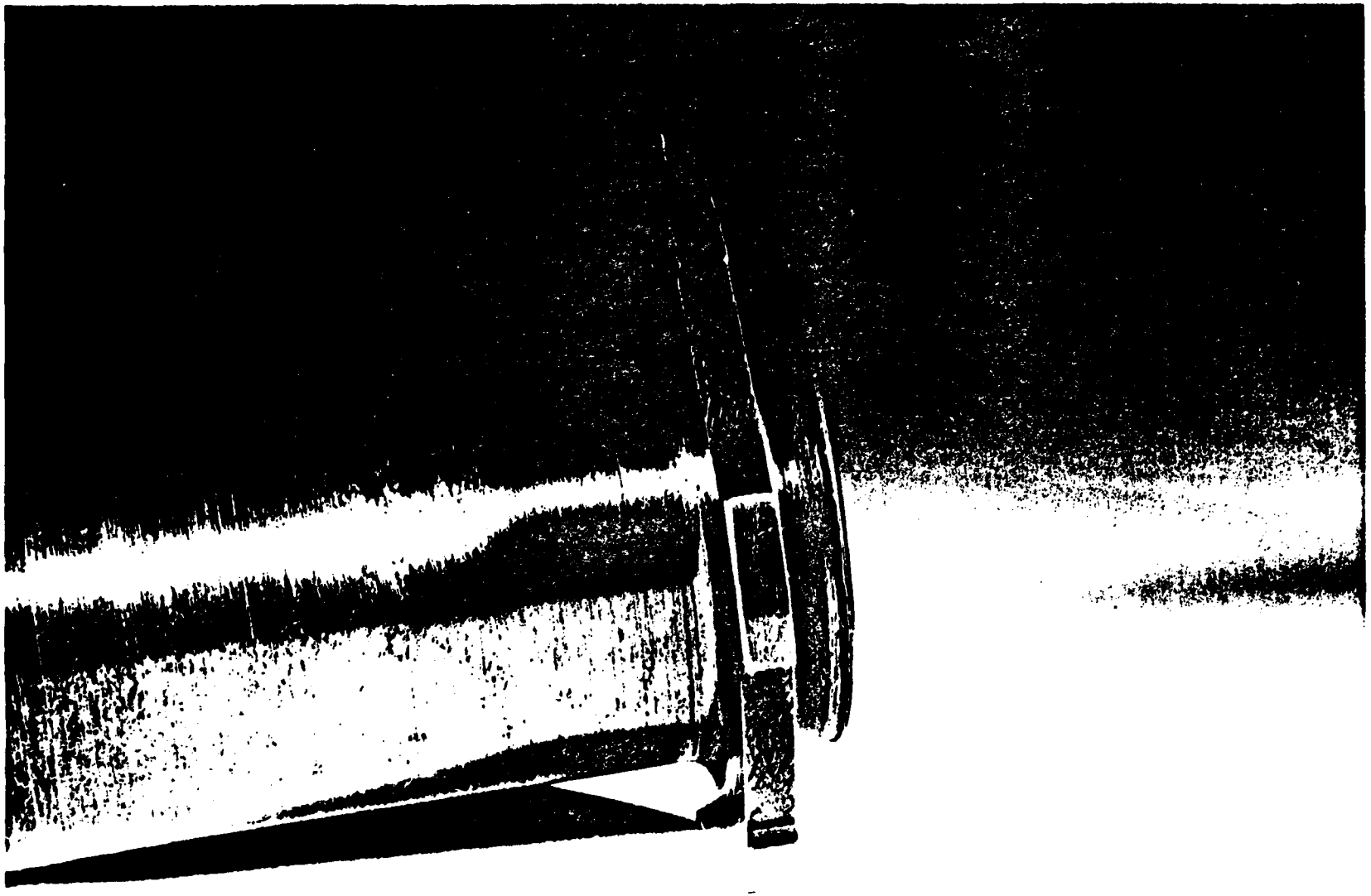

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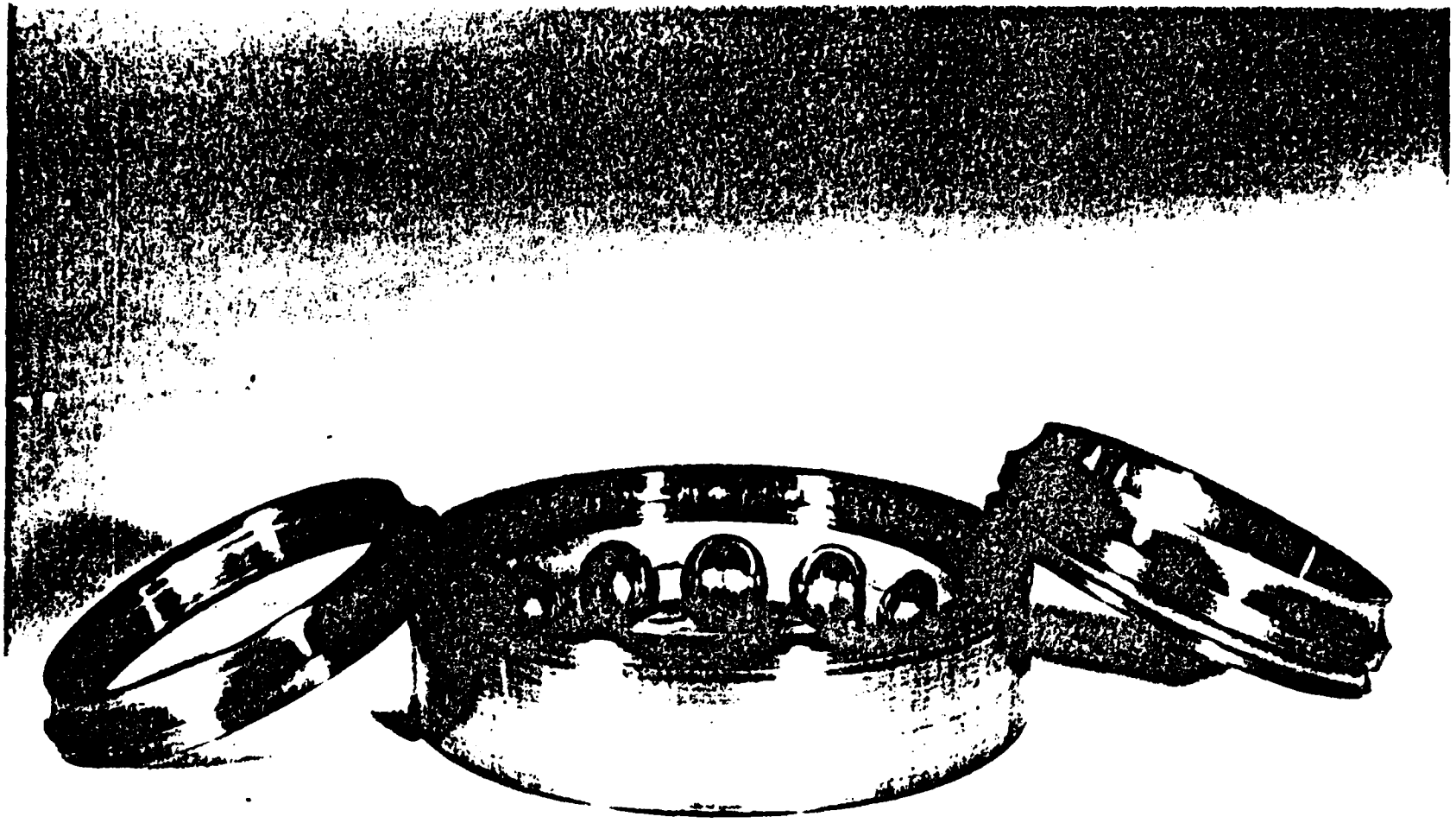

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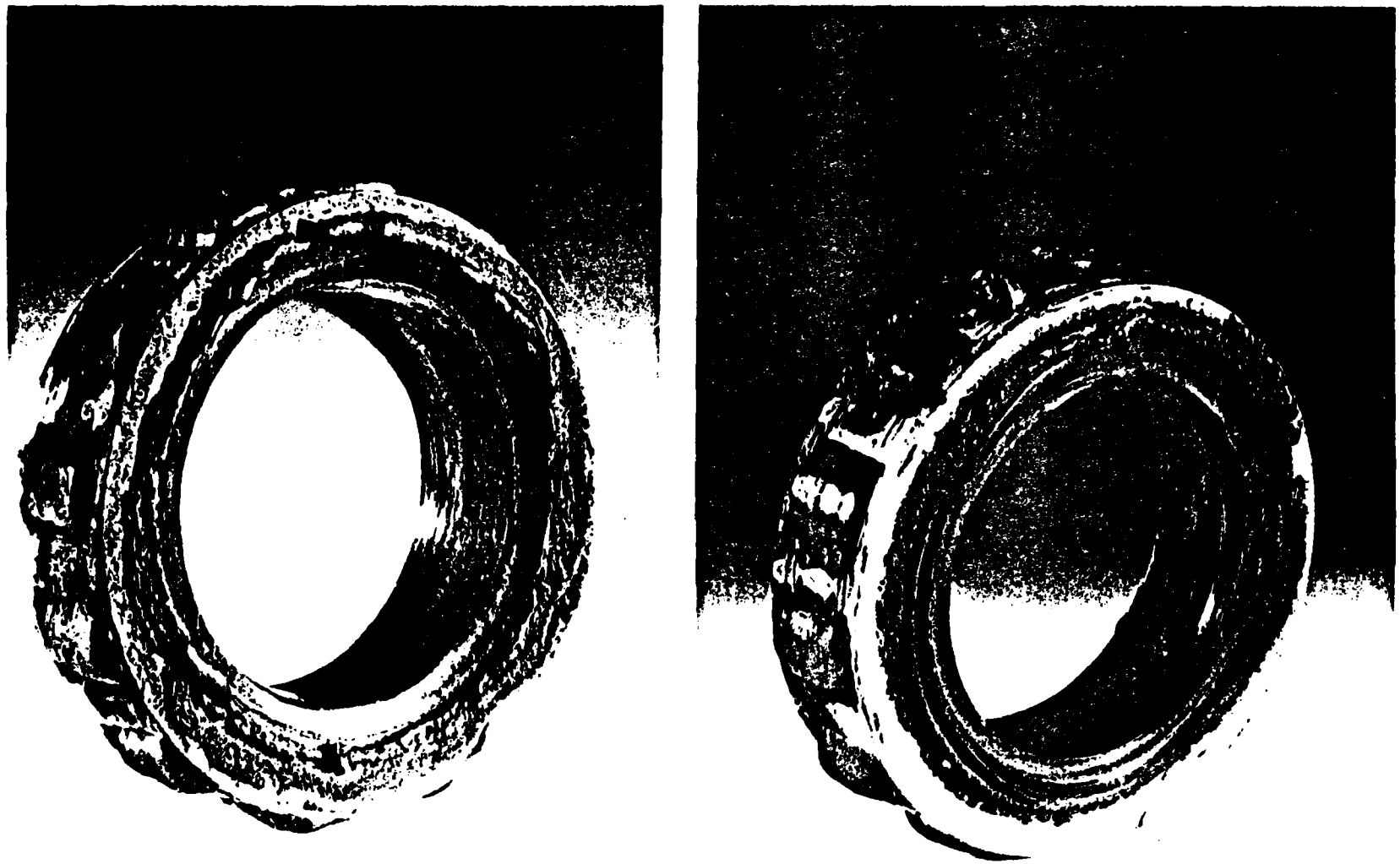

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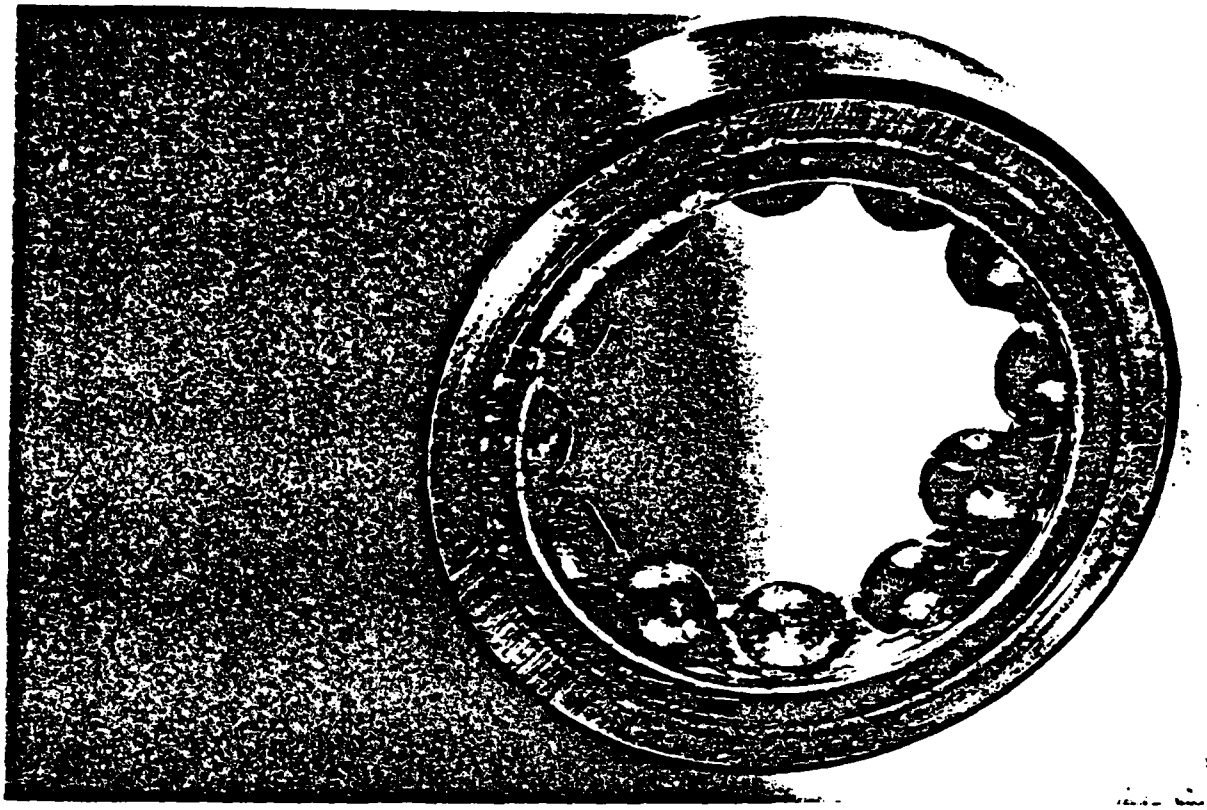

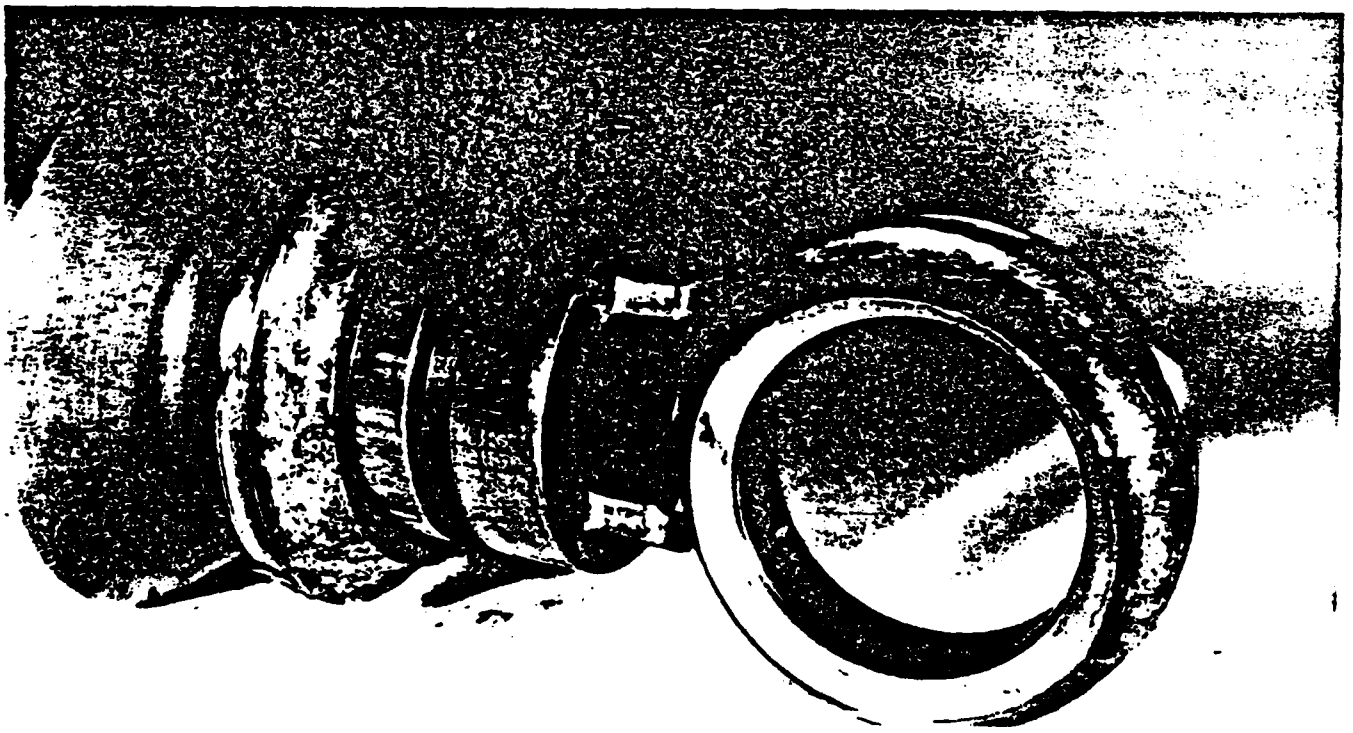

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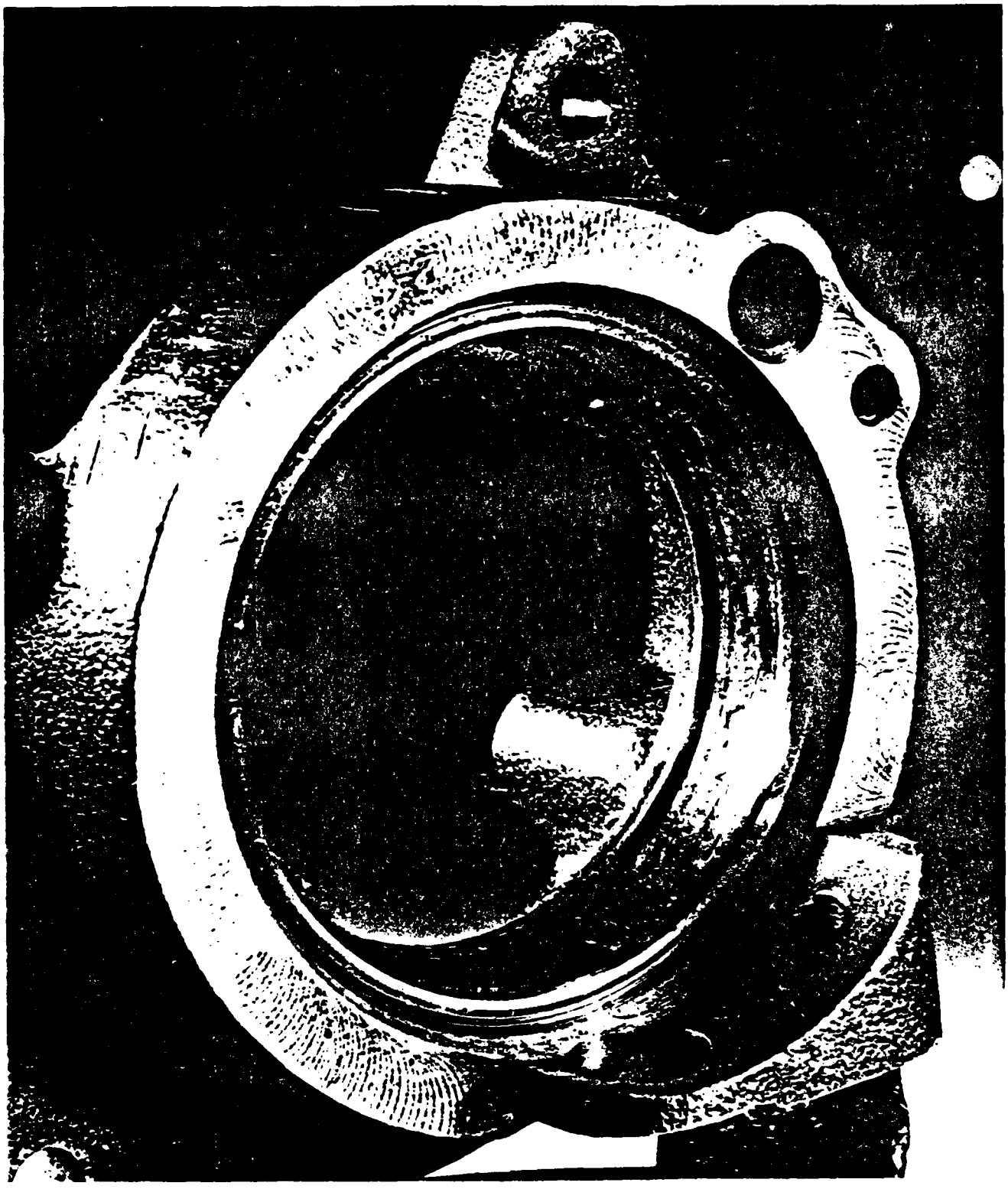

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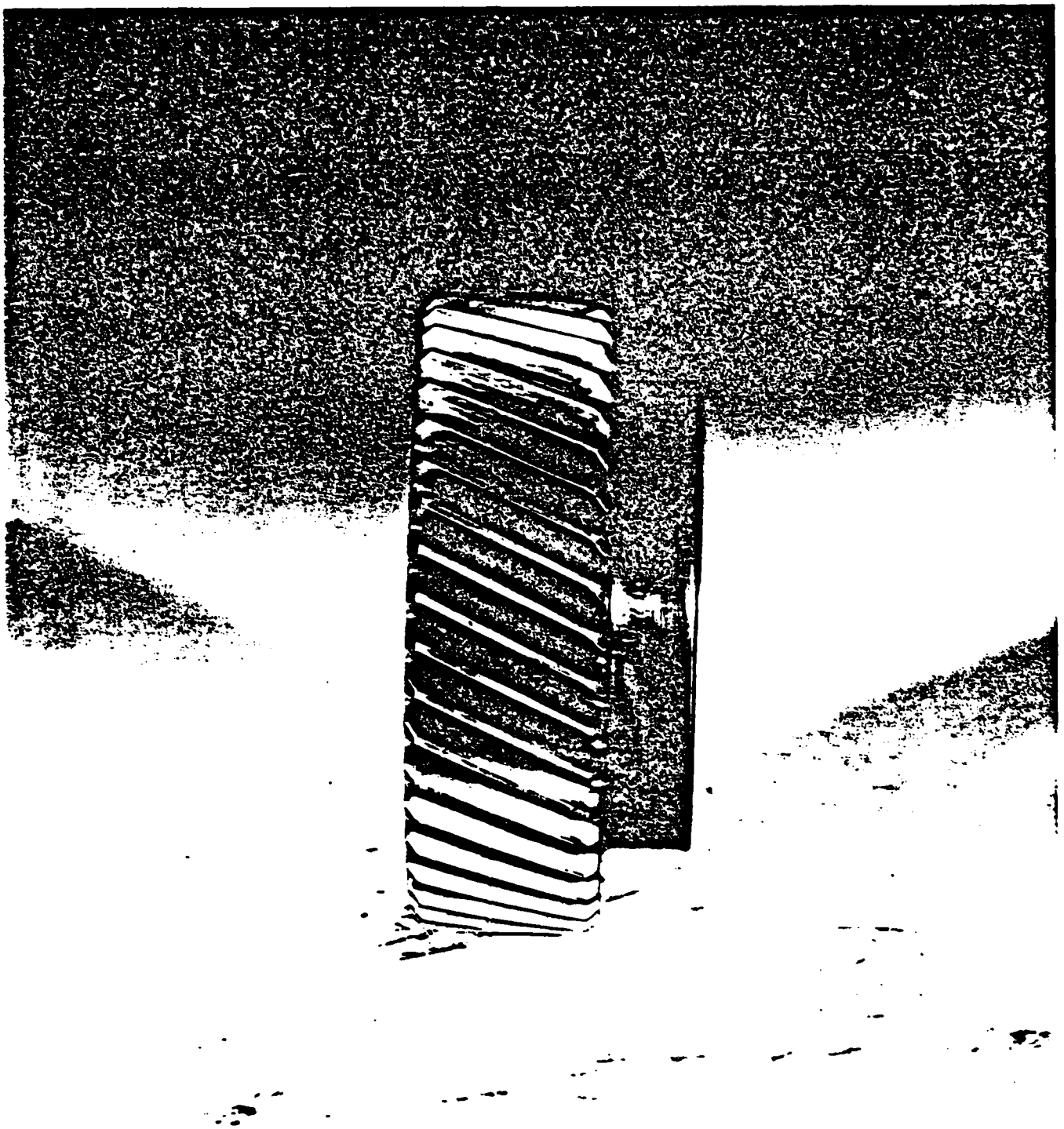

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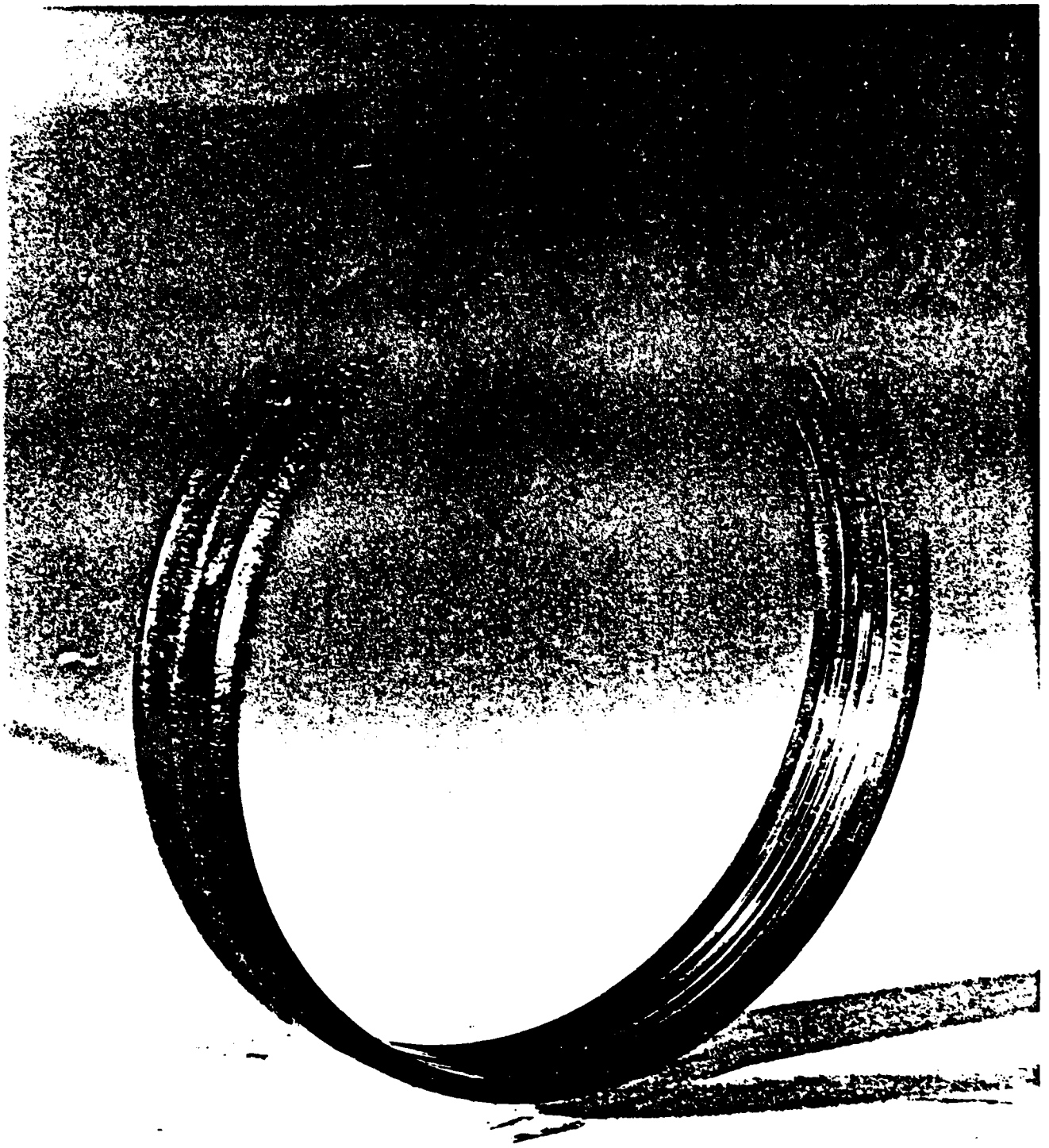

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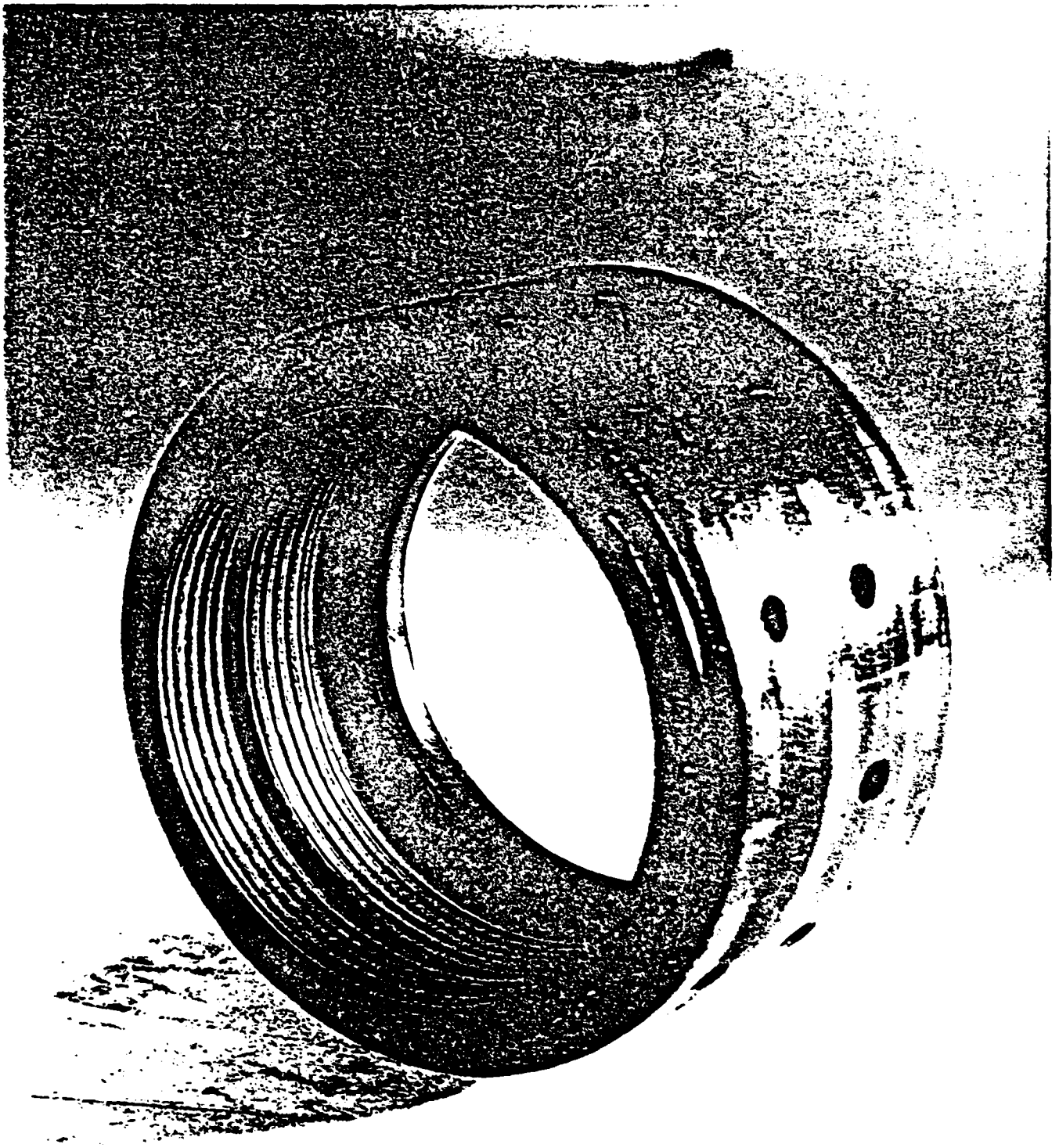

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AD-A086 035 GENERAL MOTORS CORP INDIANAPOLIS IN DETROIT DIESEL A--ETC F/G 10/2
ENVIRONMENTAL AND COLD TESTS ON MODEL 04045803 GENERATOR SET SE--ETC(U)
NOV 79 H E GASTON DAAK70-78-C-0124
UNCLASSIFIED DDA-79D87 NL

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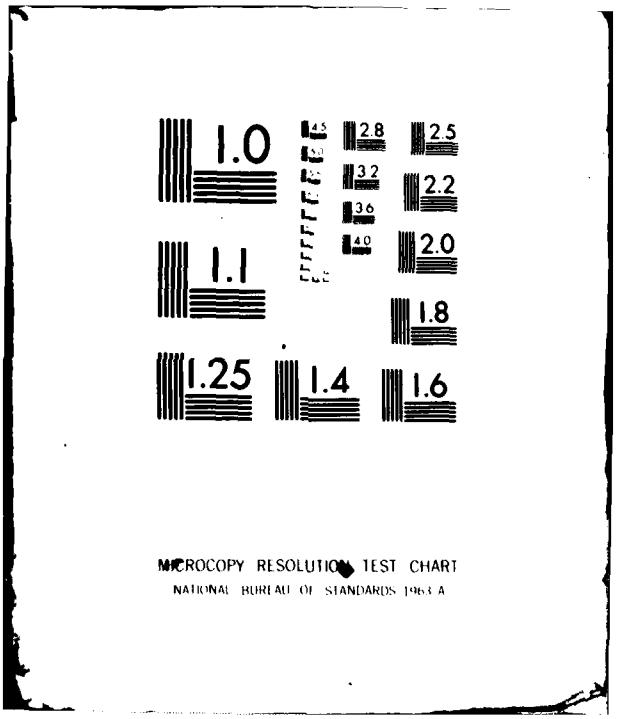
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1.1
1.25
1.4
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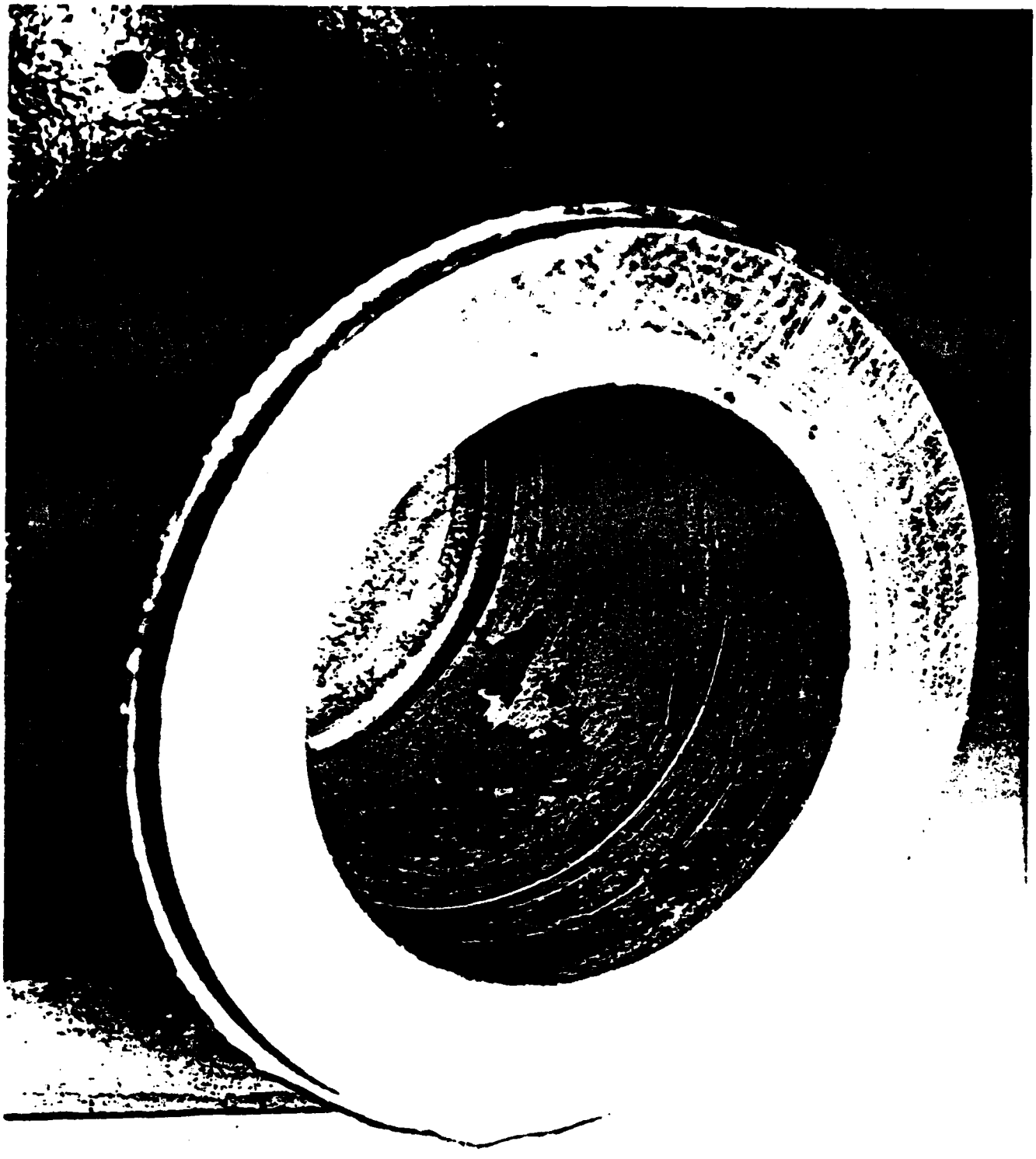
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



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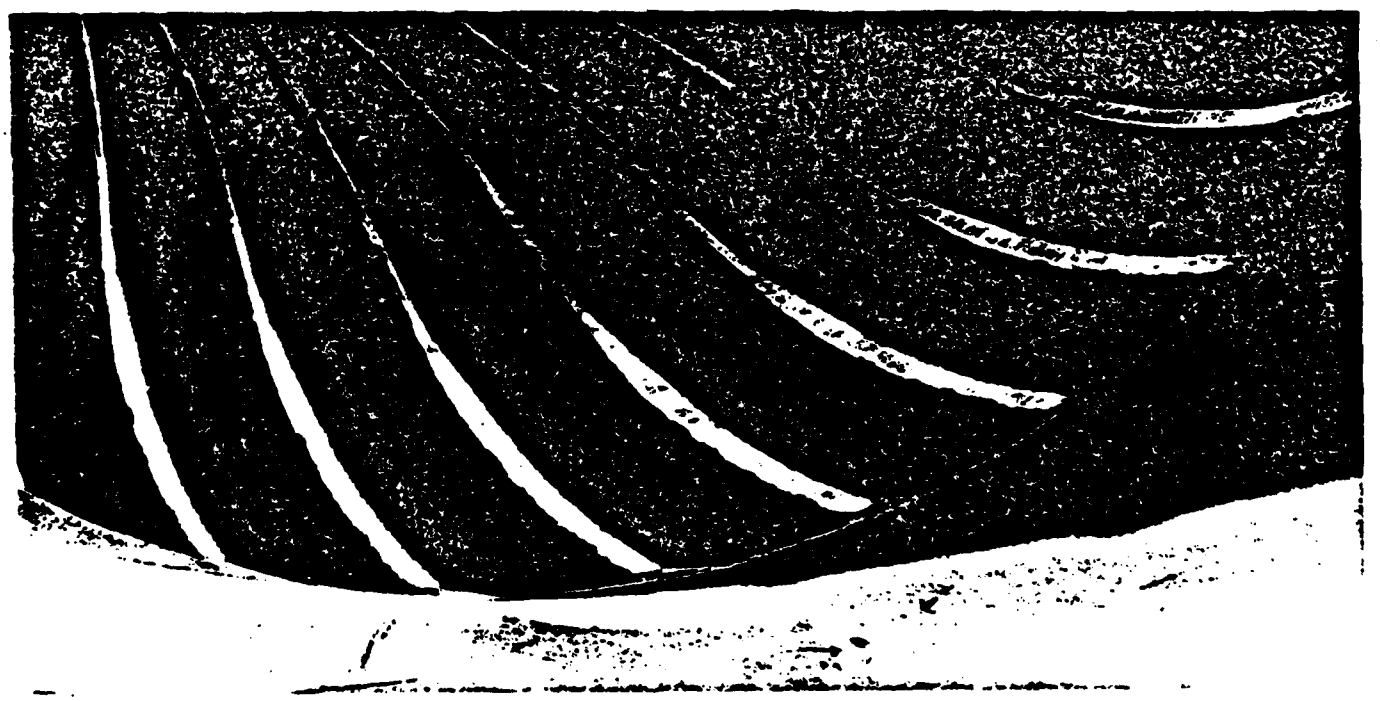

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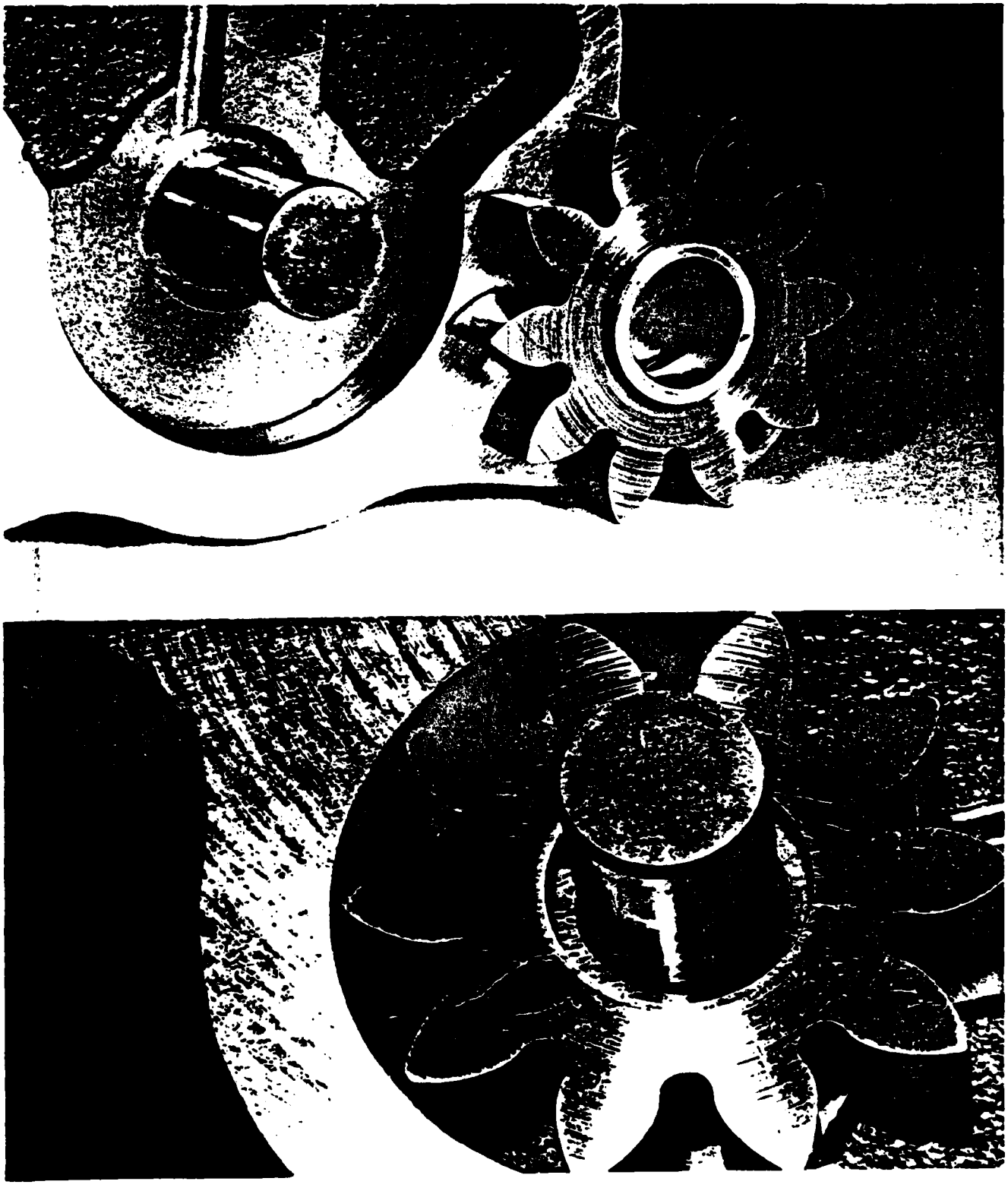

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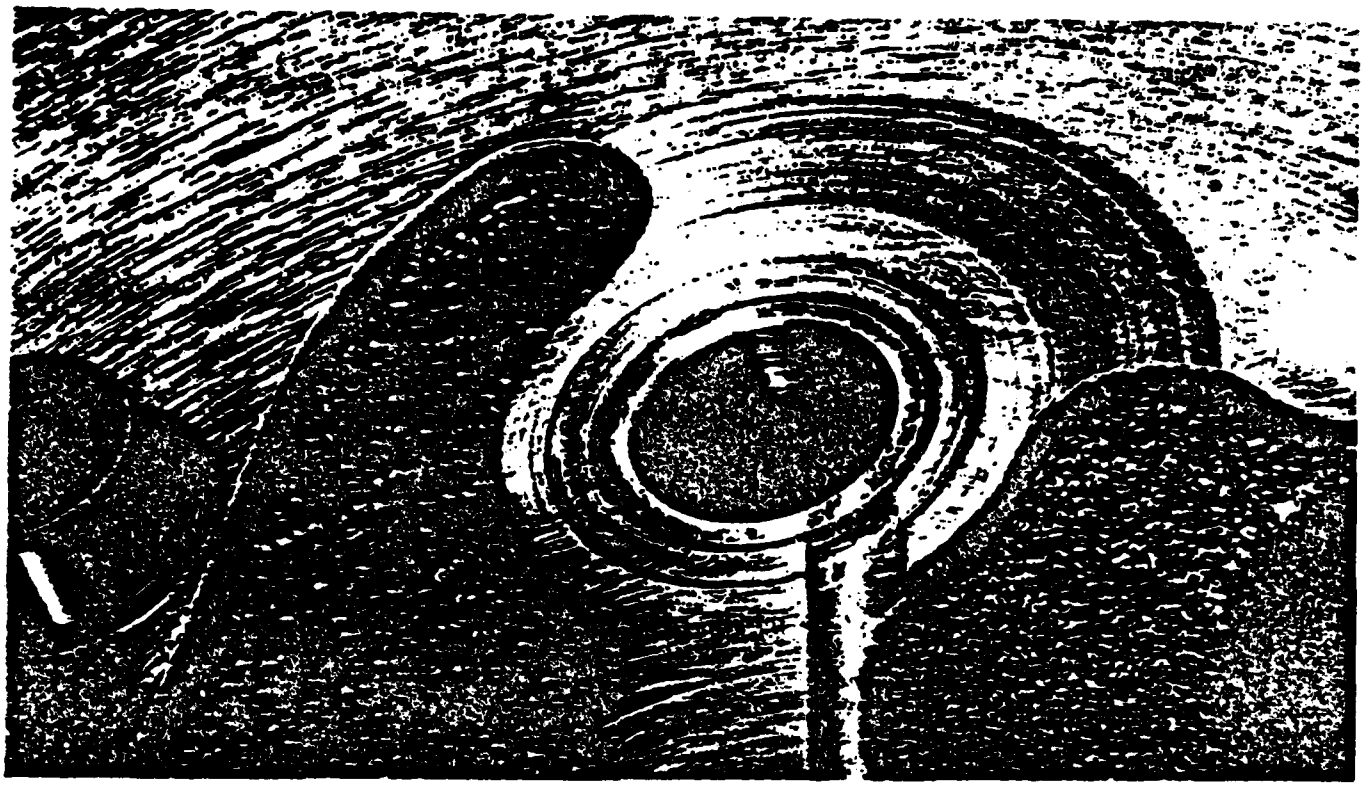

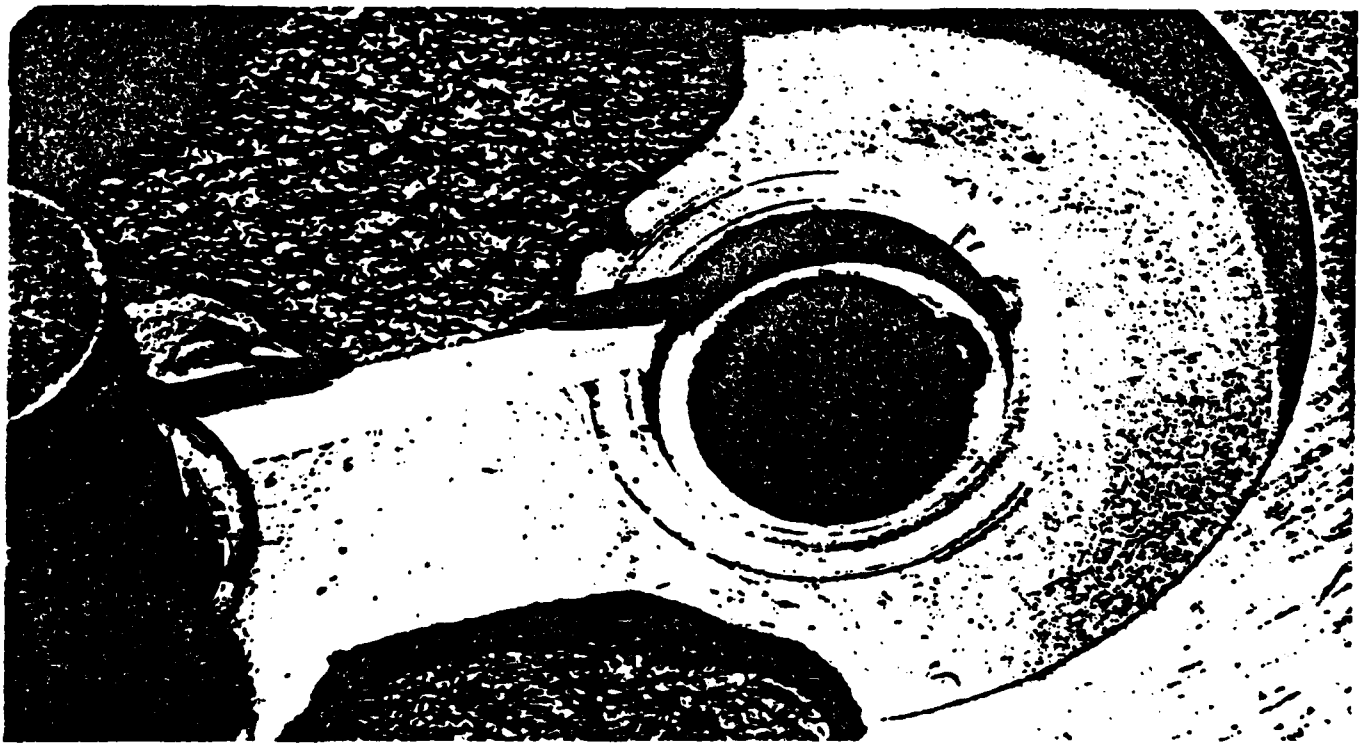

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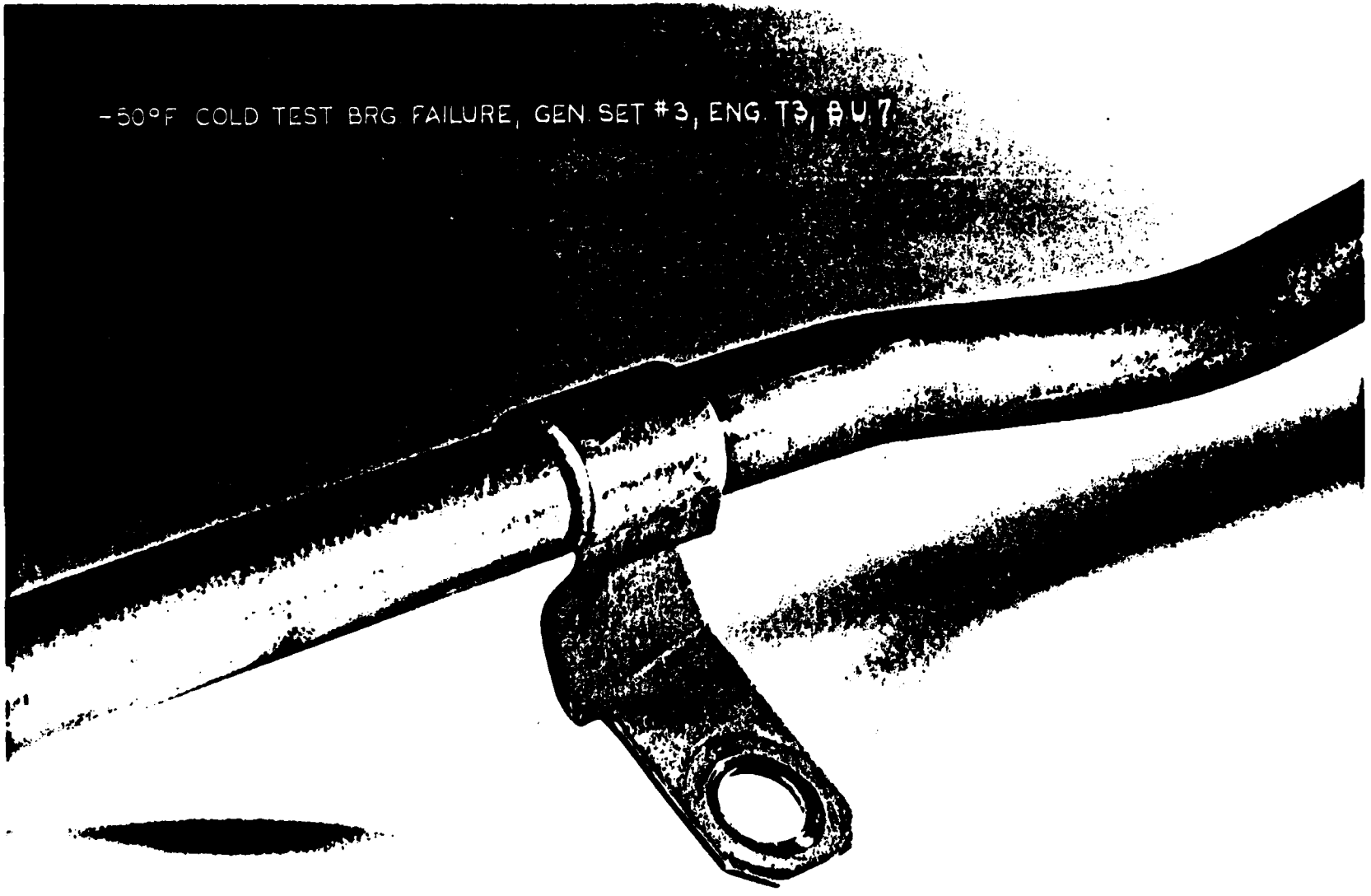
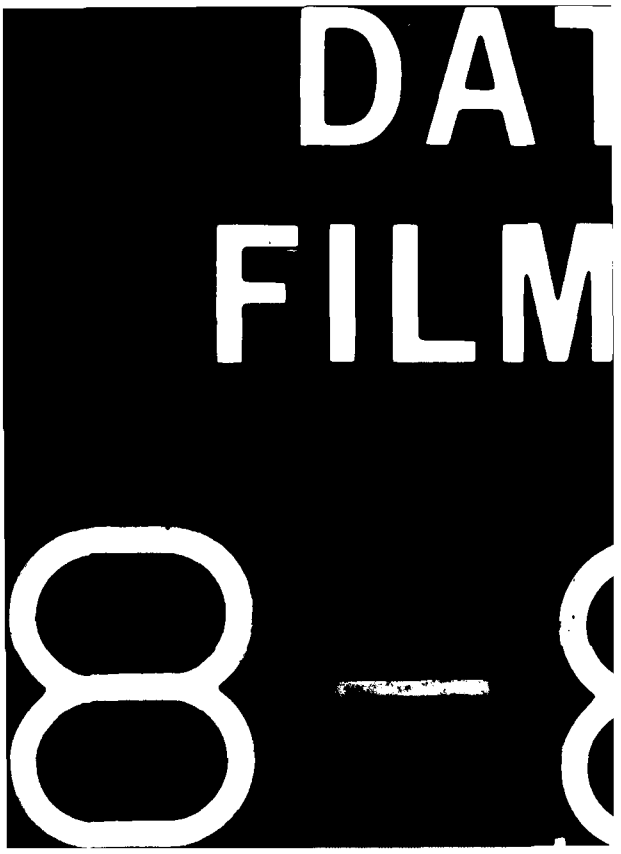



351525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